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**SWGARCH: AN ENHANCED GARCH MODEL FOR TIME
SERIES FORECASTING**

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Abstrak

Generalized Autoregressive Conditional Heteroskedasticity (GARCH) adalah salah satu model siri masa yang paling popular untuk ramalan siri masa. Model GARCH menggunakan varians jangka panjang sebagai salah satu berat. Data lampau digunakan untuk mengira varians jangka panjang kerana ia mengandaikan bahawa varians untuk tempoh masa yang panjang adalah sama dengan varians untuk tempoh masa yang singkat. Walau bagaimanapun, ini tidak mencerminkan pengaruh varians harian. Oleh itu, varians jangka panjang perlu diberi penambahbaikan untuk mengambil kira kesan seharian. Kajian ini mencadangkan model *Sliding Window GARCH (SWGARCH)* untuk meningkatkan pengiraan varians dalam model *GARCH*. Model *SWGARCH* mempunyai empat langkah. Langkah pertama adalah untuk menganggarkan parameter model *SWGARCH* dan langkah kedua adalah untuk mengira varians tingkap berdasarkan teknik gelongsor tetingkap. Langkah ketiga adalah untuk mengira pulangan tempoh dan langkah terakhir adalah untuk menanamkan varians baru yang dikira daripada data lampau dalam model yang dicadangkan. Prestasi *SWGARCH* dinilai pada tujuh (7) set data siri masa domain yang berbeza dan dibandingkan dengan empat (4) model siri masa dari segi ralat min kuasa dua dan ralat min peratusan mutlak. Prestasi *SWGARCH* adalah lebih baik daripada *GARCH*, *EGARCH*, *GJR* dan *ARIMA-GARCH* untuk empat (4) set data dari segi ralat min kuasa dua dan untuk lima (5) dari segi ralat min peratusan mutlak. Saiz tetingkap anggaran telah meningkatkan pengiraan varians jangka panjang. Penemuan mengesahkan bahawa *SWGARCH* boleh digunakan untuk ramalan siri masa dalam bidang yang berbeza.

Kata kunci: *GARCH*, Ramalan siri masa, Gelongsor tetingkap, varians jangka panjang

Abstract

Generalized Autoregressive Conditional Heteroskedasticity (GARCH) is one of most popular models for time series forecasting. The GARCH model uses the long run variance as one of the weights. Historical data is used to calculate the long run variance because it is assumed that the variance of a long period is similar to the variance of a short period. However, this does not reflect the influence of the daily variance. Thus, the long run variance needs to be enhanced to reflect the influence of each day. This study proposed the Sliding Window GARCH (SWGARCH) model to improve the calculation of the variance in the GARCH model. SWGARCH consists of four (4) main steps. The first step is to estimate the model parameters and the second step is to compute the window variance based on the sliding window technique. The third step is to compute the period return and the final step is to embed the recent variance computed from historical data in the proposed model. The performance of SWGARCH is evaluated on seven (7) time series datasets of different domains and compared with four (4) time series models in terms of mean square error and mean absolute percentage error. Performance of SWGARCH is better than the GARCH, EGARCH, GJR, and ARIMA-GARCH for four (4) datasets in terms of mean squared error and for five (5) datasets in terms of maximum absolute percentage error. The window size estimation has improved the calculation of the long run variance. Findings confirm that SWGARCH can be used for time series forecasting in different domains.

Keywords: GARCH, Time series forecasting, Sliding window, Long run variance.

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Table of Content

Permission to Use	ii
Abstrak.....	iii
Abstract.....	iv
Acknowledgement	v
List of Tables	xi
List of Figures.....	xiii
List of Abbreviations	xv
CHAPTER One INTRODUCTION.....	1
1.1 Problem Statement	4
1.2 Research Objective	5
1.3 Scope, Assumption, and Limitation.....	5
1.4 Significance of the Research.....	6
1.5 Organization of the Thesis	6
CHAPTER Two LITERATURE REVIEW	7
2.1 Time Series Analysis	7
2.2 Time Series Models	11
2.3 The ARCH/GARCH Models	13
2.3.1 Ordinary Least Squares.....	14
2.3.2 The Heteroskedasticity	15
2.3.3 Autoregressive Models	16
2.3.4 Moving Average Models	17
2.3.5 ARMA/ARIMA Models	18
2.3.6 Stationarity.....	20
2.3.7 Differencing	20
2.4 Time Series Modeling Approaches.....	22
2.4.1 The Time Series Approach	23
2.4.2 Hybrid Time Series Approach	25
2.5 Sliding Window Technique	31

2.6 Summary	33
CHAPTER Three Methodology	34
3.1 The Research Framework	34
3.2 Enhanced GARCH Model Development.....	35
3.3 Algorithm Development of SWGARCH Model.....	37
3.3.1 Estimating SWGARCH Parameters	37
3.3.2 The Return Computation	38
3.3.3 Computation of Sliding Window Variance	39
3.3.4 Recent Variance.....	40
3.3.5 SWGARCH Algorithm.....	40
3.4 Evaluation of SWGARCH Model	41
3.4.1 Datasets.....	41
3.4.2 Evaluation Metrics and Benchmark Models.....	43
3.4.3 Numeric Example	44
3.4.3.1 Estimating SWGARCH Parameters.....	45
3.4.3.2 The Return Calculation.....	46
3.4.3.3 Computation of Sliding Window Variance	47
3.4.3.4 Recent Variance.....	49
3.4.3.5 SWGARCH Variance.....	49
3.4.3.6 The Forecasting	49
3.4.3.7 SWGARCH Model Comparison.....	50
3.5 Summary	51
CHAPTER Four Experiment and Results	52
4.1 Experimental Design.....	52
4.2 Case Study of Senara Dataset in North Malaysia	53
4.2.1 Estimating SWGARCH Parameters	53
4.2.2 The Return Calculation.....	54
4.2.3 Computation of Sliding Window Variance	55
4.2.4 Recent Variance.....	57

4.2.5	SWGARCH Variance	58
4.2.6	The Forecasting.....	58
4.3	Case Study of Kuala Nerang Dataset in North Malaysia	58
4.3.1	Estimating SWGARCH Parameters	59
4.3.2	The Return Calculation.....	60
4.3.3	Computation of Sliding Window Variance	60
4.3.4	Recent Variance.....	63
4.3.5	SWGARCH Variance	63
4.3.6	The Forecasting.....	63
4.4	Case Study of House Price Index for Kuala Lumpur in Malaysia.....	64
4.4.1	Estimating SWGARCH Parameters	64
4.4.2	The Return Calculation.....	65
4.4.3	Computation of Sliding Window Variance	66
4.4.4	Recent Variance.....	68
4.4.5	SWGARCH Variance	69
4.4.6	The Forecasting.....	69
4.5	Case Study of House Price Index for Florida in the USA	69
4.5.1	Estimating SWGARCH Parameters	70
4.5.2	The Return Calculation.....	71
4.5.3	Computation of Sliding Window Variance	71
4.5.4	Recent Variance.....	74
4.5.5	SWGARCH Variance	74
4.5.6	The Forecasting.....	74
4.6	Case Study of Malaysia House Price Index.....	75
4.6.1	Estimating SWGARCH Parameters	75
4.6.2	The Return Calculation.....	76
4.6.3	Computation of Sliding Window Variance	77
4.6.4	Recent Variance.....	79
4.6.5	SWGARCH Variance	79
4.6.6	The Forecasting.....	80
4.7	Case Study of NASDAQ Index	80
4.7.1	Estimating SWGARCH Parameters	81

4.7.2 The Return Calculation.....	82
4.7.3 Computation of Sliding Window Variance	82
4.7.4 Recent Variance.....	84
4.7.5 SWGARCH Variance	85
4.7.6 The Forecasting.....	85
4.8 Case Study of Dow Jones Index	86
4.8.1 Estimating SWGARCH Parameters	86
4.8.2 The Return Calculation.....	87
4.8.3 Computation of Sliding Window Variance	88
4.8.4 Recent Variance.....	90
4.8.5 SWGARCH Variance	90
4.8.6 The Forecasting.....	91
4.9 SWGARCH Model Performance.....	91
4.9.1 The Performance of Senara Station Case Study.....	91
4.9.2 The Performance of Kuala Nerang Case Study.....	93
4.9.3 The Performance of KL HPI Case Study.....	95
4.9.4 The Performance of Florida HPI Case Study	96
4.9.5 The Performance of Malaysia HPI Case Study	98
4.9.6 The Performance of NASDAQ Index Case Study.....	99
4.9.7 The Performance of Dow Jones Index Case Study.....	100
4.10 Model Comparison.....	102
4.11 Summary	106
CHAPTER Five Conclusion and Future Work	107
5.1 Research Contribution	107
5.2 Future Work	108
APPENDIX A: SWGARCH Algorithm	115
APPENDIX B: Performance for Senara Station.....	116
APPENDIX C: Performance for Kuala Nerang.....	123
APPENDIX D: Performance for KL House Price Index.....	130
APPENDIX E: Performance for Florida House Price Index	137
APPENDIX F: Performance for Malaysia House Price Index	144
APPENDIX G: Performance for NASDAQ Index.....	146

APPENDIX H: Performance for Dow Jones Index	153
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List of Tables

Table 3.1 Sample of S&P 500 Index Dataset	44
Table 3.2 Estimation of parameters in SWGARCH model	45
Table 3.3 Computation of Return	46
Table 3.4 S&P 500 Index Variance	47
Table 3.5 Sample Data from Sliding Window for S&P 500 Index	48
Table 3.6 Sample Model Performance for S&P 500 Dataset	50
Table 3.7 Experimental Results	51
Table 4.1 Parameters Calculation for Senara Dataset.....	54
Table 4.2 Computation of Return	55
Table 4.3 Senara Dataset Water Level Variance	55
Table 4.4 Sample Data from Sliding Window for Senara Dataset	56
Table 4.5 Parameters Calculation for Kuala Nerang Dataset	59
Table 4.6 Computation of Return	60
Table 4.7 Kuala Nerang Water Level Variance	61
Table 4.8 Sample Data from Sliding Window for Kuala Nerang Dataset.....	62
Table 4.9 Parameters Calculation for KL HPI.....	65
Table 4.10 Computation of Return	66
Table 4.11 KL Index Variance.....	66
Table 4.12 Sample Data from Sliding Window for KL HPI	67
Table 4.13 Parameters Calculation for Florida HPI.....	70
Table 4.14 Computation of Return	71
Table 4.15 Florida Price Variance	72

Table 4.16 Sample Data from Sliding Window for Florida HPI	73
Table 4.17 Parameters Calculation for Malaysia HPI	76
Table 4.18 Computation of Return	77
Table 4.19 Malaysia HPI PCA Variance Explained.....	77
Table 4.20 Sample Data from Sliding Window for Malaysia HPI	78
Table 4.21 Parameters Calculation for NASDAQ Index.....	81
Table 4.22 Computation of Return	82
Table 4.23 Senara Dataset Water Level Variance	82
Table 4.24 Sample Data from Sliding Window for NASDAQ Index	83
Table 4.25 Parameters Calculation for Dow Jones Index.....	87
Table 4.26 Computation of Return	88
Table 4.27 Dow Jones Index Variance	88
Table 4.28 Sample Data from Sliding Window for Dow Jones Index	89
Table 4.29 Sample Model Performance for Senara Station.....	93
Table 4.30 Sample Model Performance for Kuala Nerang Station	94
Table 4.31 Sample Model Performance for KL House Price Index	96
Table 4.32 Sample Model Performance for Florida HPI.....	97
Table 4.33 Sample Model Performance for Malaysia House Price Index.....	99
Table 4.34 Sample Model Performance for NASDAQ Index	100
Table 4.35 Sample Model Performance for Dow Jones Index	101
Table 4.36 MSE Model Performance	102
Table 4.37 MAPE Model Performance	103

List of Figures

Figure 1.1. An example of sliding window.....	4
Figure 3.1. Research Framework	35
Figure 3.2. SWGARCH algorithm.....	37
Figure 3.3. SWGARCH pseudocode	40
Figure 3.4. Variance plot for S&P 500 Index dataset	47
Figure 4.1. Senara sample data	53
Figure 4.2. Variance plot for Senara dataset.....	56
Figure 4.3. Kuala Nerang sample data.....	58
Figure 4.4. Variance plot for Kuala Nerang dataset	61
Figure 4.5. KL HPI sample data	64
Figure 4.6. Variance plot for KL HPI dataset.....	67
Figure 4.7. Sample Florida HPI data	69
Figure 4.8. Variance plot for Florida dataset	72
Figure 4.9. Sample Malaysia HPI.....	75
Figure 4.10. Variance plot for Malaysia HPI dataset.....	78
Figure 4.11. Sample NASDAQ Index data.....	80
Figure 4.12. Variance plot for NASDAQ dataset	83
Figure 4.13. Sample Dow Jones Index data.....	86
Figure 4.14. Variance plot for Dow Jones Index	89
Figure 4.15. Actual and forecast water level for Senara station	92
Figure 4.16. Actual and forecast water level for Kuala Nerang station.....	94
Figure 4.17. Actual and forecast values for KL House Price	95

Figure 4.18. Actual and forecast value for Florida HPI.....	97
Figure 4.19. Actual and forecast value for Malaysia HPI.....	98
Figure 4.20. Actual and forecast value for NASDAQ Index.....	99
Figure 4.21. Actual and forecast value for Dow Jones Index.....	101
Figure 4.22. Geometric mean for the best MSE values	104
Figure 4.23. The percentage enhancement of each algorithm in terms of the best MSE	105
Figure 4.24. Geometric mean for the best MAPE values	105
Figure 4.25. The percentage enhancement of each algorithm in terms of the best MAPE	106



List of Abbreviations

AE	Artificial Evolution
ANN	Artificial Neural Network
AR	Moving Average
ARIMA	Autoregressive Integrated Moving Average
ARMA	Autoregressive Moving Average
BP	Backward propagation
DID	Drainage and Irrigation Department
DM	Data Mining
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedastic
GANN	Genetic Algorithms with Neural Networks
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GJR	Glosten, Jagannathan, and Runkle
GPS	Global Positioning System
GR-NN	General Regression Neural Network
LRA	Linear Regression Analysis
MA	Moving Average
MAPE	Mean Absolute Percentage Error
MSE	Mean Square Error
PCA	Principal Component Analysis
RMSE	Root Mean Squared Error
SVM	Support Vector Machine
SWGARCH	Sliding Window Generalized Autoregressive Conditional Heteroscedasticity

CHAPTER ONE

INTRODUCTION

The subject of time series analysis has drawn significant attention. Since it is of tremendous interest to practitioners, as well as to academic researchers on this topic, therefore, to make statistical inferences and forecasts of future values of the interested variables are very critical. The main targets of the time series analysis are classified into two steps: (1) identifying the mechanism of the phenomena represented by the numerical data; and (2) attempting to predict the future values of the interested variables by analyzing the past data (Cryer and Chan, 2008).

In order to accomplish both of the targets, explicitly expressed statistical models are required to describe the patterns of the observed dataset. To describe data adequately, statistical models are established based on fundamental principles. Furthermore, goodness-of-fit tests and model selection criteria are developed to verify the adequacy of the selected model in describing the data. Once the identified model is confirmed to be adequate, the prediction of the future values can be obtained by extrapolation.

A time series is a set of observations Y_t , with each observation being recorded at a specified time t (Cryer and Chan, 2008). Time series have always been used in the field of econometrics. Already at the outset, Jan Tinbergen (1939) constructed the first econometric model for the United States, and thus started the scientific research program of empirical econometrics time series models, which have wide applications in science and technology (Kirchgassner, 2007). Examples of time series can be found in almost every field of life, including economics, astronomy, physics, agriculture, disaster, medicine, genetic engineering, and commerce.

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REFERENCES

- Abarbanel, H. (1997). *Analysis of Observed Chaotic Data*. Cambridge University Press.
- Akpınar, M., & Yumusak, N. (2013). Forecasting household natural gas consumption with ARIMA model: A case study of removing cycle. In *2013 7th International Conference on Application of Information and Communication Technologies* (pp. 1–6). IEEE. doi:10.1109/ICAICT.2013.6722753
- Areekul, P., Senjyu, T., Toyama, H., & Yona, A. (2009). Combination of artificial neural network and ARIMA time series models for short term price forecasting in deregulated market. In *2009 Transmission & Distribution Conference & Exposition: Asia and Pacific* (pp. 1–4). IEEE. doi:10.1109/TD-ASIA.2009.5356936
- Awartani, B. M., & Corradi, V. (2005). Predicting the volatility of the S&P-500 stock index via GARCH models: The role of asymmetries. *International Journal of Forecasting*, 21(1), 167–183. doi:10.1016/j.ijforecast.2004.08.003
- Babu, C., & Reddy, B. (2012). Predictive data mining on Average Global Temperature using variants of ARIMA models. In *IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM - 2012)* (pp. 256–260).
- Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31(3), 307–327. doi:10.1016/0304-4076(86)90063-1
- Box, P., & Jenkins, M. (1976). *Time-Series Analysis: Forecasting and Control* (2nd ed.). San Francisco: Holden-Day.
- Box, P., Jenkins, M., & Reinsel, C. (1994). *Time Series Analysis: Forecasting and Control* (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.
- Brooks, C. (2008). *Introductory Econometrics for Finance*.
- Casella, G., Fienberg, S., & Olkin, I. (2006). *Springer Texts in Statistics. Design* (Vol. 102). doi:10.1016/j.peva.2007.06.006
- Centre National Property Information. (2015). The Malaysian House Price Index By House Type (1988 - 2015). Retrieved December 2, 2016, from <http://napic.jp-ph.gov.my/>

- Changbao, Z., Jun, Z., & Guoli, L. (2016). Research on sequence component detection algorithm based on sliding-window mean-value. In *2016 IEEE 11th Conference on Industrial Electronics and Applications (ICIEA)* 531–533. IEEE. doi:10.1109/ICIEA.2016.7603641
- Chen, J., Yong, X., Yang, S., & Liu, L. (2009). Analysis and forecast about mineral product price based on time series method. *Journal of Kunming University of Science and Technology*, 34(6), 9–14.
- Chen, P., Yuan, H., & Shu, X. (2008). Forecasting Crime Using the ARIMA Model.
- Cohen, J., Cohen, P., West, G., & Aiken, S. (2002). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. Routledge.
- Cryer, J. D., & Chan, K.-S. (2008a). *Time Series Analysis: With Applications in R* (2nd ed.).
- Cryer, J. D., & Chan, K.-S. (2008b). *Time Series Analysis. With Applications to R. Design*. doi:10.1007/978-0-387-75959-3
- Doorley, R., Pakrashi, V., Caulfield, B., & Ghosh, B. (2014). Short-term forecasting of bicycle traffic using structural time series models. In *17th International IEEE Conference on Intelligent Transportation Systems (ITSC)* (pp. 1764–1769). IEEE. doi:10.1109/ITSC.2014.6957948
- Dougherty, C. (2011). *Introduction to Econometrics* (4th Editio.). Oxford University Press.
- Engle, R. (1982). Autoregressive Conditional Heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50, 987–1007.
- Engle, R. (2001). GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics. *Journal of Economic Perspectives*, 15(4), 157–168. doi:10.1257/jep.15.4.157
- Evans, T., & McMillan, D. G. (2007). Volatility forecasts: the role of asymmetric and long-memory dynamics and regional evidence. *Applied Financial Economics*, 17(March 2015), 1421–1430. doi:10.1080/09603100601007149
- Falk, M. (University of W. (2011). A First Course on Time Series Analysis, 364.
- Falk, M., Marohn, F., Michel, R., Hofmann, D., & Macke, M. (2012). *A First Course on Time Series Analysis Examples with SAS by Chair of Statistics*. University of Wurzburg.

- Fang, L., & Shen., L. (2010). Analysis of the recent trends of mineral resources asset prices in China based on the ARIMA method. *Journal of China Mining Magazine*, 8(26–29).
- Feng, Y., & Jones, K. (2015). Comparing multilevel modelling and artificial neural networks in house price prediction. In *2015 2nd IEEE International Conference on Spatial Data Mining and Geographical Knowledge Services (ICSDM)* (pp. 108–114). IEEE. doi:10.1109/ICSDM.2015.7298035
- Forrester, E. C. (2006). A process research framework. *software Engineering Institute, Carnegie Mellon University*.
- Gershenfeld, N. (1999). *The Nature of Mathematical Modeling*. Cambridge University Press.
- Hajizadeh, E., Seifi, A., Fazel Zarandi, M. H., & Turksen, I. B. (2012). A hybrid modeling approach for forecasting the volatility of S&P 500 index return. *Expert Systems with Applications*, 39(1), 431–436. doi:10.1016/j.eswa.2011.07.033
- Hao, C., Fangxing, L., Qiulan, W., & Wang, Y. (2011). Short term load forecasting using regime-switching GARCH models. In *2011 IEEE Power and Energy Society General Meeting* (pp. 1–6). IEEE. doi:10.1109/PES.2011.6039457
- Hernandez, J., Ovando, M., Acosta, F., & Pancardo, P. (2016). Water Level Meter for Alerting Population about Floods. In *2016 IEEE 30th International Conference on Advanced Information Networking and Applications (AINA)* (pp. 879–884). IEEE. doi:10.1109/AINA.2016.76
- Hong-qiong, H., & Tian-hao, T. (2007). Short-term Traffic Flow Forecasting Based on ARIMA-ANN. *2007 IEEE International Conference on Control and Automation*, 2370–2373.
- Hull, J. C. (2002). *Options, Futures, and Other Derivatives* (5th ed.). Prentice Hall.
- Hull, J. C. (2015). *Options, Futures and Other Derivatives*. Pearson (9th ed.). Pearson.
- Jaasa, T., Androcec, I., & Sprci, P. (2011). Electricity price forecasting - ARIMA method approach. In *Proceeding of the 8th International Conference on the European Energy Market* (pp. 222–225).
- Jacasa, T., Androcec, I., & Sprci, P. (2011). Electricity price forecasting-ARIMA

- model approach. *8th International Conference on the European Energy Market*, 222–225.
- Kantz, H., & Schreiber, T. (2004). *Nonlinear Time Series Analysis* (2nd ed.). Cambridge University Press.
- Kapila Tharanga Rathnayaka, M., Seneviratna, D., Jianguo, W., & Arumawadu, H. I. (2015). A hybrid statistical approach for stock market forecasting based on Artificial Neural Network and ARIMA time series models. In *2015 International Conference on Behavioral, Economic and Socio-cultural Computing (BESC)* (pp. 54–60). IEEE. doi:10.1109/BESC.2015.7365958
- Keogh, E., Chu, S., Hart, D., & Pazzani, M. (2003). Segmenting Time Series: A Survey and Novel Approach. *Data Mining in Time Series Databases*, 1–21. doi:10.1.1.12.9924
- Khandelwal, I., Adhikari, R., & Verma, G. (2015). Time Series Forecasting Using Hybrid ARIMA and ANN Models Based on DWT Decomposition. *Procedia Computer Science*, 48, 173–179. doi:10.1016/j.procs.2015.04.167
- Khim-Sen, L., Shitan, M., & Huzaimi, H. (2007). Time series methodling and forecasting of Sarawak black pepper price. *Journal of Munich Personal RePEc Archive*, 791, 1–16.
- Kirchgassner, G. (2007). *Introduction to Modern Time Series Analysis*. Springer Berlin Heidelberg New York.
- Ku Mahamud, K. R., Zakaria, N., Katuk, N., & Shbier, M. (2009). Flood Pattern Detection Using Sliding Window Technique. In *2009 Third Asia International Conference on Modelling & Simulation* (pp. 45–50). doi:10.1109/AMS.2009.15
- Li, B. (2005). Economic forecast. *Economic Management Press*, 45–48.
- Li, S., Lin, Z., Xiao, Z., & Ma, J. (2012). The use of GARCH-neural network model for forecasting the volatility of bid-ask spread of the Chinese stock market. In *2012 International Conference on Management Science & Engineering 19th Annual Conference Proceedings* (pp. 1899–1903). doi:10.1109/ICMSE.2012.6414430
- Lu, X., Que, D., & Cao, G. (2016). Volatility Forecast Based on the Hybrid Artificial Neural Network and GARCH-type Models. *Procedia - Procedia Computer Science*, 1044–1049. doi:10.1016/j.procs.2016.07.145

- McMillan, D., Speight, A., & Apgwilym, O. (2000). Forecasting UK stock market volatility. *Applied Financial Economics*, 10(4), 435–448. doi:10.1080/09603100050031561
- Mills T. (1990). *Time Series Techniques for Economists*. Cambridge University Press.
- Monfared, S. A., & Enke, D. (2014). Volatility Forecasting Using a Hybrid GJR-GARCH Neural Network Model. *Procedia Computer Science*, 36, 246–253. doi:10.1016/j.procs.2014.09.087
- Narendra, B., & Reddy, E. (2014). Selected Indian stock predictions using a hybrid ARIMA-GARCH model. In *2014 International Conference on Advances in Electronics Computers and Communications* (pp. 1–6). IEEE. doi:10.1109/ICAIECC.2014.7002382
- National Flood Monitoring Centre. (2007). Hydrology and Water Resources Division of the Department of Irrigation and Drainage. Retrieved December 2, 2016, from <http://infobanjir.water.gov.my/>
- Nguyen, T., Khosravi, A., Nahavandi, S., & Creighton, D. (2013). Neural network and interval type-2 fuzzy system for stock price forecasting. In *2013 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)* (pp. 1–8). doi:10.1109/FUZZ-IEEE.2013.6622370
- Pang, H., & Jung, S.-H. (2013). Sample Size Considerations of Prediction-Validation Methods in High-Dimensional Data for Survival Outcomes. *Genetic Epidemiology*, 37(3), 276–282. doi:10.1002/gepi.21721
- Percival, B., & Walden, T. (1993). *Spectral Analysis for Physical Applications*. Cambridge University Press.
- Puspitasari, I., Akbar, M. S., & Lee, M. H. (2012). Two-level seasonal model based on hybrid ARIMA-ANFIS for forecasting short-term electricity load in Indonesia. In *2012 International Conference on Statistics in Science, Business and Engineering (ICSSBE)* (pp. 1–5). IEEE. doi:10.1109/ICSSBE.2012.6396642
- Rahman, M., Islam, S., Nadvi, S. Y., & Rahman, R. M. (2013). Comparative Study of ANFIS and ARIMA Model for Weather Forecasting in Dhaka.
- Shatkey, H., & Zdonik, S. B. (1996). Approximate queries and representations for large data sequences. *Proceedings of the Twelfth International Conference on Data Engineering*, 536–545. doi:10.1109/ICDE.1996.492204

- Sibel, H., & Yayar, R. (2006). Forecasting of Sunflower Oil Price in Turkey. *Application and Science Research*, 2(9), 572–578.
- Strickland, J. (2015). *Predictive Analytics using R*. Lulu.com.
- Tang, R., Feng, T., Sha, Q., & Zhang, S. (2009). A Variable-Sized Sliding-Window Approach for Genetic Association Studies via Principal Component Analysis. *Annals of Human Genetics*, 73(6), 631–637. doi:10.1111/j.1469-1809.2009.00543.x
- Taylor, J. W., & Taylor, J. W. (2004). Smooth Transition Exponential Smoothing. *Smooth Transition Exponential Smoothing*, 23, 385–394.
- Tinbergen, J. (1939). A Method and Its Application to Business Cycle Theory. *Statistical Analysis of Business Cycle Theories*.
- Wong, B. (2014). Introduction to (Generalized) Autoregressive Conditional Heteroskedasticity Models in Time Series Econometrics.
- Xie, M., Sandels, C., Zhu, K., & Nordstrom, L. (2013). A seasonal ARIMA model with exogenous variables for elspot electricity prices in Sweden. In *2013 10th International Conference on the European Energy Market (EEM)* (pp. 1–4). IEEE. doi:10.1109/EEM.2013.6607293
- Yin, D., & Chen, W. (2016). The forecast of USD/CNY exchange rate based on the Elman neural network with volatility updating. In *2016 35th Chinese Control Conference (CCC)* (pp. 9562–9566). IEEE. doi:10.1109/ChiCC.2016.7554875
- Yorucu, V. (2003). The Analysis of Forecasting Performance by Using Time Series Data for Two Mediterranean Islands. *Review of Social, Economic & Business Studies*, 2, 175–196.
- Zhang, G. (2003). Time series forecasting using a hybrid ARIMA and neural network model. *Neurocomputing*, 50, 159–175.
- Zou, W., & Guo, M. (2014). Using CARR model and GARCH model to forecast volatility of the stock index: Evidence from China's Shanghai stock market. In *2014 International Conference on Management Science & Engineering 21th Annual Conference Proceedings* (pp. 1106–1112). IEEE. doi:10.1109/ICMSE.2014.6930352

APPENDIX A: SWGARCH Algorithm

Window variance procedure

```
while (@@FETCH_STATUS = 0)
begin
    select @Return1=[Return] from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID
    select @Return=[Return] from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID-1
    select @Return3=[Return] from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID-2

    set @WindowVariance =(@Return1 *.5) +(@Return *.33)+(@Return3 *.1667)

    fetch next from cur into @DataID,@DataVal
end
```

SWGARCH Procedure

```
fetch next from cur into @DataID,@DataVal
while (@@FETCH_STATUS = 0)
begin
    select @WindowVariance=WindowVariance from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID
    select @WindowVariance1=WindowVariance from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID-1
    select @Variance1=Variance from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID-1
    select @Return=[Return] from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID
    select @Return1=[Return] from [dbo].[CaseData]
    Where CaseID=@CaseID and DataID=@DataID-1
    set @i=@i+1
    if @i=1
        set @Variance =@WindowVariance1
    else
        set @Variance =(@WindowVariance * @gamma)+(@Variance1 * @beta)+(@Return1
        *@alpha )

    fetch next from cur into @DataID,@DataVal
end
```

Forecast Procedure

```
fetch next from cur into @DataID
while (@@FETCH_STATUS = 0)
begin
    ForecastVariance=round(windowvariance+(@alpha+@beta)*(swgarch-
    windowvariance),4),
    Forecast=round([DataVal] + ([DataVal] *
    round(windowvariance+(@alpha+@beta)*
    (swgarch-windowvariance),4)) ,4)
    fetch next from cur into @DataID
end
```

APPENDIX B: Performance for Senara Station

Model Performance for Senara Station

Date	Day _i	Water Level	Forecast Value	Error
Mon, Mar 19, 2007	78	0.65	0.65	0.0020
Tue, Mar 20, 2007	79	0.83	0.83	0.0018
Wed, Mar 21, 2007	80	0.68	0.68	0.0174
Thu, Mar 22, 2007	81	0.63	0.63	0.0255
Fri, Mar 23, 2007	82	0.97	0.97	0.0258
Sat, Mar 24, 2007	83	0.79	0.79	0.0662
Sun, Mar 25, 2007	84	0.87	0.87	0.0806
Mon, Mar 26, 2007	85	0.76	0.76	0.0353
Tue, Mar 27, 2007	86	0.85	0.85	0.0145
Wed, Mar 28, 2007	87	0.91	0.91	0.0125
Thu, Mar 29, 2007	88	0.85	0.85	0.0080
Fri, Mar 30, 2007	89	0.89	0.89	0.0049
Sat, Mar 31, 2007	90	0.85	0.85	0.0029
Sun, Apr 01, 2007	91	0.89	0.89	0.0021
Mon, Apr 02, 2007	92	0.8	0.8	0.0016
Tue, Apr 03, 2007	93	0.74	0.74	0.0043
Wed, Apr 04, 2007	94	0.61	0.61	0.0045
Thu, Apr 05, 2007	95	0.71	0.71	0.0137
Fri, Apr 06, 2007	96	0.89	0.89	0.0224
Sat, Apr 07, 2007	97	0.91	0.91	0.0321
Sun, Apr 08, 2007	98	0.75	0.75	0.0179
Mon, Apr 09, 2007	99	0.83	0.83	0.0187
Tue, Apr 10, 2007	100	0.65	0.65	0.0125
Wed, Apr 11, 2007	101	0.8	0.8	0.0269
Thu, Apr 12, 2007	102	1.2	1.2	0.0516
Fri, Apr 13, 2007	103	1.52	1.52	0.1408

Date	Day_i	Water Level	Forecast Value	 Error
Sat, Apr 14, 2007	104	1.15	1.15	0.1089
Sun, Apr 15, 2007	105	0.95	0.95	0.0731
Mon, Apr 16, 2007	106	1.13	1.13	0.0609
Tue, Apr 17, 2007	107	1.35	1.35	0.0509
Wed, Apr 18, 2007	108	1.15	1.15	0.0346
Thu, Apr 19, 2007	109	0.98	0.98	0.0268
Fri, Apr 20, 2007	110	0.86	0.86	0.0216
Sat, Apr 21, 2007	111	0.83	0.83	0.0173
Sun, Apr 22, 2007	112	1	1	0.0109
Mon, Apr 23, 2007	113	1.58	1.58	0.0269
Tue, Apr 24, 2007	114	1.71	1.71	0.1701
Wed, Apr 25, 2007	115	2.49	2.49	0.2270
Thu, Apr 26, 2007	116	3.28	3.28	0.2924
Fri, Apr 27, 2007	117	3.46	3.46	0.3062
Sat, Apr 28, 2007	118	2.75	2.75	0.1407
Sun, Apr 29, 2007	119	1.94	1.94	0.0645
Mon, Apr 30, 2007	120	2.15	2.15	0.1531
Tue, May 01, 2007	121	1.75	1.75	0.1057
Wed, May 02, 2007	122	1.68	1.68	0.0645
Thu, May 03, 2007	123	2.23	2.23	0.0427
Fri, May 04, 2007	124	1.66	1.66	0.0652
Sat, May 05, 2007	125	1.4	1.4	0.0951
Sun, May 06, 2007	126	1.25	1.25	0.0723
Mon, May 07, 2007	127	0.96	0.96	0.0278
Tue, May 08, 2007	128	1.01	1.01	0.0380
Wed, May 09, 2007	129	0.9	0.9	0.0277
Thu, May 10, 2007	130	1.8	1.8	0.0290
Fri, May 11, 2007	131	2.41	2.41	0.4862
Sat, May 12, 2007	132	1.72	1.72	0.3940
Sun, May 13, 2007	133	1.22	1.22	0.1795
Mon, May 14, 2007	134	1.21	1.21	0.1279

Date	Day_i	Water Level	Forecast Value	 Error
Tue, May 15, 2007	135	1	1	0.0631
Wed, May 16, 2007	136	0.75	0.75	0.0234
Thu, May 17, 2007	137	0.92	0.92	0.0445
Fri, May 18, 2007	138	2.7	2.7	0.1491
Sat, May 19, 2007	139	2.78	2.78	1.3931
Sun, May 20, 2007	140	1.67	1.67	0.7857
Mon, May 21, 2007	141	1.22	1.22	0.3257
Tue, May 22, 2007	142	1.12	1.12	0.1622
Wed, May 23, 2007	143	1.08	1.08	0.0848
Thu, May 24, 2007	144	0.84	0.84	0.0145
Fri, May 25, 2007	145	0.93	0.93	0.0254
Sat, May 26, 2007	146	0.86	0.86	0.0256
Sun, May 27, 2007	147	0.91	0.91	0.0140
Mon, May 28, 2007	148	0.84	0.84	0.0044
Tue, May 29, 2007	149	0.92	0.92	0.0044
Wed, May 30, 2007	150	0.86	0.86	0.0055
Thu, May 31, 2007	151	0.73	0.73	0.0044
Fri, Jun 01, 2007	152	0.93	0.93	0.0130
Sat, Jun 02, 2007	153	0.81	0.81	0.0286
Sun, Jun 03, 2007	154	0.83	0.83	0.0290
Mon, Jun 04, 2007	155	2.17	2.17	0.0348
Tue, Jun 05, 2007	156	3.07	3.07	1.1658
Wed, Jun 06, 2007	157	3.17	3.17	1.3288
Thu, Jun 07, 2007	158	2.17	2.17	0.3833
Fri, Jun 08, 2007	159	1.42	1.42	0.1080
Sat, Jun 09, 2007	160	0.95	0.95	0.1246
Sun, Jun 10, 2007	161	1.04	1.04	0.1642
Mon, Jun 11, 2007	162	0.98	0.98	0.0912
Tue, Jun 12, 2007	163	0.79	0.79	0.0215
Wed, Jun 13, 2007	164	0.79	0.79	0.0170
Thu, Jun 14, 2007	165	1	1	0.0191

Date	Day_i	Water Level	Forecast Value	 Error
Fri, Jun 15, 2007	166	1.32	1.32	0.0384
Sat, Jun 16, 2007	167	2.31	2.31	0.1241
Sun, Jun 17, 2007	168	2.32	2.32	0.3859
Mon, Jun 18, 2007	169	2.1	2.1	0.2859
Tue, Jun 19, 2007	170	2.04	2.04	0.0969
Wed, Jun 20, 2007	171	2.87	2.87	0.0128
Thu, Jun 21, 2007	172	2.79	2.79	0.1374
Fri, Jun 22, 2007	173	2.08	2.08	0.0980
Sat, Jun 23, 2007	174	1.5	1.5	0.0775
Sun, Jun 24, 2007	175	1.13	1.13	0.0885
Mon, Jun 25, 2007	176	1.11	1.11	0.0971
Tue, Jun 26, 2007	177	1.13	1.13	0.0532
Wed, Jun 27, 2007	178	1.26	1.26	0.0144
Thu, Jun 28, 2007	179	1.04	1.04	0.0052
Fri, Jun 29, 2007	180	0.85	0.85	0.0168
Sat, Jun 30, 2007	181	0.87	0.87	0.0287
Sun, Jul 01, 2007	182	0.84	0.84	0.0182
Mon, Jul 02, 2007	183	0.7	0.7	0.0045
Tue, Jul 03, 2007	184	0.7	0.7	0.0099
Wed, Jul 04, 2007	185	0.84	0.84	0.0113
Thu, Jul 05, 2007	186	0.83	0.83	0.0151
Fri, Jul 06, 2007	187	0.87	0.87	0.0116
Sat, Jul 07, 2007	188	0.89	0.89	0.0050
Sun, Jul 08, 2007	189	0.9	0.9	0.0010
Mon, Jul 09, 2007	190	1.07	1.07	0.0006
Tue, Jul 10, 2007	191	1.09	1.09	0.0134
Wed, Jul 11, 2007	192	1.39	1.39	0.0169
Thu, Jul 12, 2007	193	1.06	1.06	0.0301
Fri, Jul 13, 2007	194	0.94	0.94	0.0505
Sat, Jul 14, 2007	195	0.95	0.95	0.0413
Sun, Jul 15, 2007	196	0.89	0.89	0.0143

Date	Day_i	Water Level	Forecast Value	 Error
Mon, Jul 16, 2007	197	1.99	1.99	0.0076
Tue, Jul 17, 2007	198	1.73	1.73	0.4600
Wed, Jul 18, 2007	199	1.21	1.21	0.3242
Thu, Jul 19, 2007	200	0.94	0.94	0.1408
Fri, Jul 20, 2007	201	0.75	0.75	0.0601
Sat, Jul 21, 2007	202	1.63	1.63	0.1044
Sun, Jul 22, 2007	203	1.99	1.99	0.5476
Mon, Jul 23, 2007	204	2.22	2.22	0.5877
Tue, Jul 24, 2007	205	2.23	2.23	0.2327
Wed, Jul 25, 2007	206	1.66	1.66	0.0175
Thu, Jul 26, 2007	207	1.35	1.35	0.0503
Fri, Jul 27, 2007	208	1.89	1.89	0.0989
Sat, Jul 28, 2007	209	1.78	1.78	0.1342
Sun, Jul 29, 2007	210	2.41	2.41	0.1272
Mon, Jul 30, 2007	211	2.15	2.15	0.1174
Tue, Jul 31, 2007	212	1.89	1.89	0.0806
Wed, Aug 01, 2007	213	1.62	1.62	0.0401
Thu, Aug 02, 2007	214	1.3	1.3	0.0237
Fri, Aug 03, 2007	215	1.17	1.17	0.0370
Sat, Aug 04, 2007	216	1.13	1.13	0.0308
Sun, Aug 05, 2007	217	1.05	1.05	0.0122
Mon, Aug 06, 2007	218	0.89	0.89	0.0038
Tue, Aug 07, 2007	219	0.84	0.84	0.0113
Wed, Aug 08, 2007	220	0.82	0.82	0.0107
Thu, Aug 09, 2007	221	0.78	0.78	0.0042
Fri, Aug 10, 2007	222	0.71	0.71	0.0012
Sat, Aug 11, 2007	223	0.73	0.73	0.0034
Sun, Aug 12, 2007	224	0.7	0.7	0.0029
Mon, Aug 13, 2007	225	0.66	0.66	0.0015
Tue, Aug 14, 2007	226	0.72	0.72	0.0016
Wed, Aug 15, 2007	227	0.76	0.76	0.0036

Date	Day_i	Water Level	Forecast Value	 Error
Thu, Aug 16, 2007	228	0.91	0.91	0.0043
Fri, Aug 17, 2007	229	1.26	1.26	0.0195
Sat, Aug 18, 2007	230	1.11	1.11	0.0628
Sun, Aug 19, 2007	231	1.17	1.17	0.0626
Mon, Aug 20, 2007	232	1.6	1.6	0.0356
Tue, Aug 21, 2007	233	1.33	1.33	0.0577
Wed, Aug 22, 2007	234	1.39	1.39	0.0745
Thu, Aug 23, 2007	235	1.19	1.19	0.0334
Fri, Aug 24, 2007	236	0.99	0.99	0.0152
Sat, Aug 25, 2007	237	0.89	0.89	0.0212
Sun, Aug 26, 2007	238	0.89	0.89	0.0192
Mon, Aug 27, 2007	239	0.97	0.97	0.0090
Tue, Aug 28, 2007	240	0.78	0.78	0.0036
Wed, Aug 29, 2007	241	1.15	1.15	0.0257
Thu, Aug 30, 2007	242	1.43	1.43	0.1166
Fri, Aug 31, 2007	243	1.31	1.31	0.1131
Sat, Sep 01, 2007	244	1.07	1.07	0.0461
Sun, Sep 02, 2007	245	1.71	1.71	0.0452
Mon, Sep 03, 2007	246	2.21	2.21	0.2368
Tue, Sep 04, 2007	247	1.6	1.6	0.1929
Wed, Sep 05, 2007	248	1.2	1.2	0.1193
Thu, Sep 06, 2007	249	1.04	1.04	0.0882
Fri, Sep 07, 2007	250	0.91	0.91	0.0510
Sat, Sep 08, 2007	251	1.31	1.31	0.0354
Sun, Sep 09, 2007	252	1.22	1.22	0.0783
Mon, Sep 10, 2007	253	0.98	0.98	0.0566
Tue, Sep 11, 2007	254	0.81	0.81	0.0324
Wed, Sep 12, 2007	255	0.7	0.7	0.0243
Thu, Sep 13, 2007	256	0.82	0.82	0.0245
Fri, Sep 14, 2007	257	1.62	1.62	0.0386
Sat, Sep 15, 2007	258	2.71	2.71	0.5478

Date	Day_i	Water Level	Forecast Value	 Error
Sun, Sep 16, 2007	259	3.03	3.03	0.9005
Mon, Sep 17, 2007	260	4.19	4.19	0.7349
Tue, Sep 18, 2007	261	4.16	4.16	0.3525
Wed, Sep 19, 2007	262	3.9	3.9	0.1714
Thu, Sep 20, 2007	263	3.37	3.37	0.0549
Fri, Sep 21, 2007	264	2.51	2.51	0.0262
Sat, Sep 22, 2007	265	1.92	1.92	0.0855
Sun, Sep 23, 2007	266	1.68	1.68	0.1126
Mon, Sep 24, 2007	267	2.02	2.02	0.0971
Tue, Sep 25, 2007	268	1.48	1.48	0.0459
Wed, Sep 26, 2007	269	1.49	1.49	0.0828
Thu, Sep 27, 2007	270	1.2	1.2	0.0522
Fri, Sep 28, 2007	271	1.2	1.2	0.0391
Sat, Sep 29, 2007	272	0.92	0.92	0.0173
Sun, Sep 30, 2007	273	1.29	1.29	0.0455
Mon, Oct 01, 2007	274	1.76	1.76	0.1319
Tue, Oct 02, 2007	275	3.86	3.86	0.3664
		Water Level	Average Error	0.1088

APPENDIX C: Performance for Kuala Nerang

Model Performance for Kuala Nerang

Date	Day i	Water Level	Forecast Value	Error
Tue, Mar 20, 2007	79	14.3	14.3	0.1573
Wed, Mar 21, 2007	80	14.3	14.31	0.1147
Thu, Mar 22, 2007	81	14.3	14.31	0.0566
Fri, Mar 23, 2007	82	14.3	14.31	0.0266
Sat, Mar 24, 2007	83	14.3	14.33	0.0063
Sun, Mar 25, 2007	84	15	14.98	0.0022
Mon, Mar 26, 2007	85	13.8	13.78	0.0075
Tue, Mar 27, 2007	86	14.2	14.22	0.0359
Wed, Mar 28, 2007	87	14.3	14.34	0.0481
Thu, Mar 29, 2007	88	14.7	14.66	0.0310
Fri, Mar 30, 2007	89	14.6	14.59	0.0170
Sat, Mar 31, 2007	90	14	14.04	0.0069
Sun, Apr 01, 2007	91	14.2	14.19	0.0082
Mon, Apr 02, 2007	92	14.1	14.06	0.0096
Tue, Apr 03, 2007	93	14.8	14.77	0.0060
Wed, Apr 04, 2007	94	15.2	15.19	0.0127
Thu, Apr 05, 2007	95	14.9	14.94	0.0179
Fri, Apr 06, 2007	96	14.8	14.81	0.0136
Sat, Apr 07, 2007	97	14.8	14.76	0.0083
Sun, Apr 08, 2007	98	14.7	14.73	0.0035
Mon, Apr 09, 2007	99	14.7	14.73	0.0013
Tue, Apr 10, 2007	100	14.9	14.9	0.0005
Wed, Apr 11, 2007	101	14.9	14.91	0.0006
Thu, Apr 12, 2007	102	14.6	14.62	0.0008
Fri, Apr 13, 2007	103	13.9	13.88	0.0018
Sat, Apr 14, 2007	104	13.4	13.36	0.0112
Sun, Apr 15, 2007	105	13.3	13.3	0.0198
Mon, Apr 16, 2007	106	13.7	13.72	0.0163

Date	Day <i>i</i>	Water Level	Forecast Value	 Error
Tue, Apr 17, 2007	107	13	13.04	0.0113
Wed, Apr 18, 2007	108	13.4	13.43	0.0168
Thu, Apr 19, 2007	109	13.6	13.57	0.0200
Fri, Apr 20, 2007	110	13.3	13.32	0.0139
Sat, Apr 21, 2007	111	13.3	13.28	0.0083
Sun, Apr 22, 2007	112	13.6	13.62	0.0044
Mon, Apr 23, 2007	113	14.4	14.38	0.0042
Tue, Apr 24, 2007	114	13.5	13.45	0.0140
Wed, Apr 25, 2007	115	13.2	13.19	0.0318
Thu, Apr 26, 2007	116	13.1	13.14	0.0331
Fri, Apr 27, 2007	117	13.4	13.36	0.0194
Sat, Apr 28, 2007	118	13.2	13.16	0.0094
Sun, Apr 29, 2007	119	13.8	13.76	0.0046
Mon, Apr 30, 2007	120	12.9	12.94	0.0091
Tue, May 01, 2007	121	13.8	13.84	0.0250
Wed, May 02, 2007	122	13.3	13.33	0.0407
Thu, May 03, 2007	123	13.6	13.57	0.0424
Fri, May 04, 2007	124	12.8	12.84	0.0264
Sat, May 05, 2007	125	12.6	12.61	0.0226
Sun, May 06, 2007	126	12.5	12.48	0.0202
Mon, May 07, 2007	127	13.2	13.2	0.0122
Tue, May 08, 2007	128	13.9	13.94	0.0177
Wed, May 09, 2007	129	14.4	14.35	0.0301
Thu, May 10, 2007	130	15	15	0.0312
Fri, May 11, 2007	131	15.1	15.12	0.0274
Sat, May 12, 2007	132	14.5	14.47	0.0196
Sun, May 13, 2007	133	14.3	14.34	0.0161
Mon, May 14, 2007	134	14.1	14.09	0.0147
Tue, May 15, 2007	135	14	14.03	0.0083
Wed, May 16, 2007	136	14.5	14.48	0.0054
Thu, May 17, 2007	137	14.4	14.44	0.0056

Date	Day <i>i</i>	Water Level	Forecast Value	 Error
Fri, May 18, 2007	138	14.7	14.65	0.0065
Sat, May 19, 2007	139	14.5	14.49	0.0041
Sun, May 20, 2007	140	14.8	14.78	0.0033
Mon, May 21, 2007	141	13.8	13.8	0.0030
Tue, May 22, 2007	142	13.7	13.73	0.0191
Wed, May 23, 2007	143	14.6	14.6	0.0280
Thu, May 24, 2007	144	14.6	14.61	0.0295
Fri, May 25, 2007	145	14.7	14.7	0.0291
Sat, May 26, 2007	146	14.8	14.77	0.0139
Sun, May 27, 2007	147	14.8	14.75	0.0069
Mon, May 28, 2007	148	14.7	14.71	0.0017
Tue, May 29, 2007	149	15	14.95	0.0007
Wed, May 30, 2007	150	12.6	12.58	0.0011
Thu, May 31, 2007	151	13.6	13.61	0.1034
Fri, Jun 01, 2007	152	13.7	13.69	0.1787
Sat, Jun 02, 2007	153	13.6	13.64	0.1204
Sun, Jun 03, 2007	154	13.6	13.6	0.0625
Mon, Jun 04, 2007	155	13.9	13.94	0.0193
Tue, Jun 05, 2007	156	14.1	14.05	0.0076
Wed, Jun 06, 2007	157	13.4	13.38	0.0051
Thu, Jun 07, 2007	158	13.2	13.21	0.0106
Fri, Jun 08, 2007	159	14	14	0.0147
Sat, Jun 09, 2007	160	13.5	13.52	0.0196
Sun, Jun 10, 2007	161	13.7	13.65	0.0260
Mon, Jun 11, 2007	162	15.8	15.76	0.0204
Tue, Jun 12, 2007	163	13.7	13.7	0.0806
Wed, Jun 13, 2007	164	13.3	13.33	0.1747
Thu, Jun 14, 2007	165	15.2	15.15	0.1853
Fri, Jun 15, 2007	166	15.4	15.42	0.1680
Sat, Jun 16, 2007	167	16.4	16.4	0.1501
Sun, Jun 17, 2007	168	16.4	16.36	0.0868

Date	Day <i>i</i>	Water Level	Forecast Value	 Error
Mon, Jun 18, 2007	169	14	14.02	0.0496
Tue, Jun 19, 2007	170	13.6	13.59	0.0992
Wed, Jun 20, 2007	171	13.7	13.71	0.1366
Thu, Jun 21, 2007	172	13.5	13.53	0.0766
Fri, Jun 22, 2007	173	13.5	13.45	0.0393
Sat, Jun 23, 2007	174	13	13.01	0.0100
Sun, Jun 24, 2007	175	12.9	12.87	0.0071
Mon, Jun 25, 2007	176	12.8	12.78	0.0071
Tue, Jun 26, 2007	177	12.9	12.85	0.0042
Wed, Jun 27, 2007	178	12.8	12.76	0.0023
Thu, Jun 28, 2007	179	12.7	12.66	0.0010
Fri, Jun 29, 2007	180	12.6	12.58	0.0007
Sat, Jun 30, 2007	181	12.5	12.53	0.0007
Sun, Jul 01, 2007	182	12.5	12.49	0.0005
Mon, Jul 02, 2007	183	12.9	12.85	0.0003
Tue, Jul 03, 2007	184	13.5	13.45	0.0029
Wed, Jul 04, 2007	185	14.1	14.11	0.0118
Thu, Jul 05, 2007	186	14.4	14.4	0.0224
Fri, Jul 06, 2007	187	14.4	14.42	0.0219
Sat, Jul 07, 2007	188	14.4	14.42	0.0130
Sun, Jul 08, 2007	189	14.4	14.42	0.0057
Mon, Jul 09, 2007	190	14.6	14.57	0.0017
Tue, Jul 10, 2007	191	13.2	13.18	0.0008
Wed, Jul 11, 2007	192	13.1	13.09	0.0338
Thu, Jul 12, 2007	193	12.7	12.73	0.0496
Fri, Jul 13, 2007	194	12.6	12.56	0.0300
Sat, Jul 14, 2007	195	13	12.95	0.0188
Sun, Jul 15, 2007	196	12.8	12.76	0.0091
Mon, Jul 16, 2007	197	12.7	12.71	0.0079
Tue, Jul 17, 2007	198	12.7	12.65	0.0045
Wed, Jul 18, 2007	199	13.1	13.07	0.0023

Date	Day <i>i</i>	Water Level	Forecast Value	 Error
Thu, Jul 19, 2007	200	13.8	13.76	0.0046
Fri, Jul 20, 2007	201	14.6	14.62	0.0160
Sat, Jul 21, 2007	202	13.9	13.94	0.0304
Sun, Jul 22, 2007	203	13.2	13.2	0.0352
Mon, Jul 23, 2007	204	13.6	13.61	0.0371
Tue, Jul 24, 2007	205	13.6	13.6	0.0318
Wed, Jul 25, 2007	206	13.3	13.26	0.0180
Thu, Jul 26, 2007	207	12.9	12.92	0.0100
Fri, Jul 27, 2007	208	13.9	13.91	0.0086
Sat, Jul 28, 2007	209	13.5	13.51	0.0246
Sun, Jul 29, 2007	210	13.8	13.82	0.0351
Mon, Jul 30, 2007	211	13.5	13.5	0.0233
Tue, Jul 31, 2007	212	13.8	13.75	0.0156
Wed, Aug 01, 2007	213	13.3	13.31	0.0084
Thu, Aug 02, 2007	214	13	12.99	0.0082
Fri, Aug 03, 2007	215	12.8	12.84	0.0093
Sat, Aug 04, 2007	216	12.7	12.72	0.0070
Sun, Aug 05, 2007	217	12.6	12.63	0.0042
Mon, Aug 06, 2007	218	12.6	12.56	0.0021
Tue, Aug 07, 2007	219	12.5	12.52	0.0011
Wed, Aug 08, 2007	220	12.9	12.86	0.0006
Thu, Aug 09, 2007	221	12.9	12.86	0.0026
Fri, Aug 10, 2007	222	12.8	12.82	0.0036
Sat, Aug 11, 2007	223	12.8	12.81	0.0020
Sun, Aug 12, 2007	224	12.8	12.79	0.0011
Mon, Aug 13, 2007	225	12.8	12.79	0.0003
Tue, Aug 14, 2007	226	12.8	12.79	0.0001
Wed, Aug 15, 2007	227	12.8	12.8	0.0000
Thu, Aug 16, 2007	228	12.8	12.78	0.0000
Fri, Aug 17, 2007	229	12.8	12.8	0.0000
Sat, Aug 18, 2007	230	12.6	12.56	0.0000

Date	Day <i>i</i>	Water Level	Forecast Value	Error
Sun, Aug 19, 2007	231	12.5	12.48	0.0011
Mon, Aug 20, 2007	232	12.9	12.9	0.0019
Tue, Aug 21, 2007	233	13.2	13.24	0.0049
Wed, Aug 22, 2007	234	12.7	12.66	0.0081
Thu, Aug 23, 2007	235	12.6	12.59	0.0128
Fri, Aug 24, 2007	236	12.5	12.46	0.0130
Sat, Aug 25, 2007	237	12.5	12.45	0.0071
Sun, Aug 26, 2007	238	12.7	12.73	0.0037
Mon, Aug 27, 2007	239	12.7	12.73	0.0026
Tue, Aug 28, 2007	240	12.8	12.8	0.0028
Wed, Aug 29, 2007	241	12.7	12.74	0.0016
Thu, Aug 30, 2007	242	13	12.97	0.0010
Fri, Aug 31, 2007	243	12.8	12.83	0.0014
Sat, Sep 01, 2007	244	12.8	12.81	0.0021
Sun, Sep 02, 2007	245	14.1	14.08	0.0017
Mon, Sep 03, 2007	246	13.8	13.82	0.0319
Tue, Sep 04, 2007	247	13.2	13.17	0.0466
Wed, Sep 05, 2007	248	12.8	12.78	0.0338
Thu, Sep 06, 2007	249	12.6	12.59	0.0273
Fri, Sep 07, 2007	250	13.6	13.59	0.0156
Sat, Sep 08, 2007	251	13.6	13.62	0.0283
Sun, Sep 09, 2007	252	12.7	12.7	0.0314
Mon, Sep 10, 2007	253	12.6	12.58	0.0322
Tue, Sep 11, 2007	254	12.5	12.5	0.0320
Wed, Sep 12, 2007	255	13.2	13.22	0.0164
Thu, Sep 13, 2007	256	13.3	13.33	0.0187
Fri, Sep 14, 2007	257	13.3	13.29	0.0182
Sat, Sep 15, 2007	258	13.8	13.76	0.0104
Sun, Sep 16, 2007	259	13.7	13.66	0.0093
Mon, Sep 17, 2007	260	14.9	14.92	0.0084
Tue, Sep 18, 2007	261	15	15.01	0.0340

Date	Day <i>i</i>	Water Level	Forecast Value	 Error
Wed, Sep 19, 2007	262	14.8	14.75	0.0465
Thu, Sep 20, 2007	263	13.6	13.6	0.0245
Fri, Sep 21, 2007	264	12.8	12.84	0.0339
Sat, Sep 22, 2007	265	12.7	12.67	0.0458
Sun, Sep 23, 2007	266	12.7	12.7	0.0359
Mon, Sep 24, 2007	267	13	12.95	0.0198
Tue, Sep 25, 2007	268	13.5	13.52	0.0089
Wed, Sep 26, 2007	269	13.5	13.45	0.0103
Thu, Sep 27, 2007	270	13.4	13.42	0.0114
Fri, Sep 28, 2007	271	13.3	13.33	0.0062
Sat, Sep 29, 2007	272	13.3	13.28	0.0031
Sun, Sep 30, 2007	273	13.7	13.7	0.0010
Mon, Oct 01, 2007	274	14.1	14.07	0.0039
Tue, Oct 02, 2007	275	14.4	14.39	0.0081
		Water Level	Average Error	0.0229

APPENDIX D: Performance for KL House Price Index

Model Performance for KL House Price Index

Date	Week <i>i</i>	Forecast Value	Forecast Value	Error
Sun, Feb 17, 2013	58	57.5327	54	3.5327
Sun, Feb 24, 2013	59	45.5500	43	2.5500
Sun, Mar 03, 2013	60	36.9469	35	1.9469
Sun, Mar 10, 2013	61	45.7006	43	2.7006
Sun, Mar 17, 2013	62	68.8322	65	3.8322
Sun, Mar 24, 2013	63	76.0610	72	4.0610
Sun, Mar 31, 2013	64	85.3449	80	5.3449
Sun, Apr 07, 2013	65	67.8145	65	2.8145
Sun, Apr 14, 2013	66	53.2766	50	3.2766
Sun, Apr 21, 2013	67	70.9140	69	1.9140
Sun, Apr 28, 2013	68	41.6317	40	1.6317
Sun, May 05, 2013	69	57.4563	53	4.4563
Sun, May 12, 2013	70	65.0703	58	7.0703
Sun, May 19, 2013	71	66.9294	61	5.9294
Sun, May 26, 2013	72	55.5613	50	5.5613
Sun, Jun 02, 2013	73	72.7097	70	2.7097
Sun, Jun 09, 2013	74	61.8397	60	1.8397
Sun, Jun 16, 2013	75	75.9349	73	2.9349
Sun, Jun 23, 2013	76	66.5534	64	2.5534
Sun, Jun 30, 2013	77	45.2582	43	2.2582
Sun, Jul 07, 2013	78	50.8542	49	1.8542
Sun, Jul 14, 2013	79	83.6201	79	4.6201
Sun, Jul 21, 2013	80	47.6478	45	2.6478
Sun, Jul 28, 2013	81	82.5951	72	10.5951
Sun, Aug 04, 2013	82	76.7458	67	9.7458
Sun, Aug 11, 2013	83	65.8111	56	9.8111
Sun, Aug 18, 2013	84	67.3786	59	8.3786
Sun, Aug 25, 2013	85	57.6906	53	4.6906

Sun, Sep 01, 2013	86	58.9646	58	0.9646
Sun, Sep 08, 2013	87	75.3857	74	1.3857
Sun, Sep 15, 2013	88	61.8443	61	0.8443
Sun, Sep 22, 2013	89	41.0141	40	1.0141
Sun, Sep 29, 2013	90	68.7079	66	2.7079
Sun, Oct 06, 2013	91	61.4773	56	5.4773
Sun, Oct 13, 2013	92	71.7900	65	6.7900
Sun, Oct 20, 2013	93	48.4989	44	4.4989
Sun, Oct 27, 2013	94	58.8619	53	5.8619
Sun, Nov 03, 2013	95	55.1715	52	3.1715
Sun, Nov 10, 2013	96	104.0800	100	4.0800
Sun, Nov 17, 2013	97	72.8375	66	6.8375
Sun, Nov 24, 2013	98	49.1381	43	6.1381
Sun, Dec 01, 2013	99	99.0936	88	11.0936
Sun, Dec 08, 2013	100	60.7438	48	12.7438
Sun, Dec 15, 2013	101	68.0577	54	14.0577
Sun, Dec 22, 2013	102	50.5006	41	9.5006
Sun, Dec 29, 2013	103	53.0540	43	10.0540
Sun, Jan 05, 2014	104	53.0014	46	7.0014
Sun, Jan 12, 2014	105	67.9590	66	1.9590
Sun, Jan 19, 2014	106	30.3680	29	1.3680
Sun, Jan 26, 2014	107	50.1643	45	5.1643
Sun, Feb 02, 2014	108	59.5172	49	10.5172
Sun, Feb 09, 2014	109	68.7862	58	10.7862
Sun, Feb 16, 2014	110	52.5328	42	10.5328
Sun, Feb 23, 2014	111	31.7882	29	2.7882
Sun, Mar 02, 2014	112	32.8233	31	1.8233
Sun, Mar 09, 2014	113	58.5263	55	3.5263
Sun, Mar 16, 2014	114	42.6374	39	3.6374
Sun, Mar 23, 2014	115	49.2102	43	6.2102
Sun, Mar 30, 2014	116	54.1105	50	4.1105
Sun, Apr 06, 2014	117	69.9657	62	7.9657

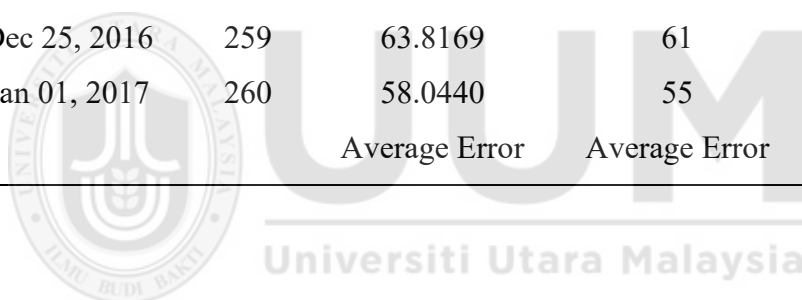
Sun, Apr 13, 2014	118	50.7576	48	2.7576
Sun, Apr 20, 2014	119	59.8061	58	1.8061
Sun, Apr 27, 2014	120	31.1190	30	1.1190
Sun, May 04, 2014	121	74.7539	69	5.7539
Sun, May 11, 2014	122	58.3326	48	10.3326
Sun, May 18, 2014	123	78.3673	62	16.3673
Sun, May 25, 2014	124	79.1756	62	17.1756
Sun, Jun 01, 2014	125	70.8739	56	14.8739
Sun, Jun 08, 2014	126	33.1776	31	2.1776
Sun, Jun 15, 2014	127	85.9131	80	5.9131
Sun, Jun 22, 2014	128	44.2953	37	7.2953
Sun, Jun 29, 2014	129	90.3761	67	23.3761
Sun, Jul 06, 2014	130	75.6610	53	22.6610
Sun, Jul 13, 2014	131	83.9165	57	26.9165
Sun, Jul 20, 2014	132	91.7468	72	19.7468
Sun, Jul 27, 2014	133	51.7252	45	6.7252
Sun, Aug 03, 2014	134	51.5630	48	3.5630
Sun, Aug 10, 2014	135	65.5848	61	4.5848
Sun, Aug 17, 2014	136	77.3911	73	4.3911
Sun, Aug 24, 2014	137	64.4650	59	5.4650
Sun, Aug 31, 2014	138	49.3640	48	1.3640
Sun, Sep 07, 2014	139	53.1416	51	2.1416
Sun, Sep 14, 2014	140	66.9696	65	1.9696
Sun, Sep 21, 2014	141	56.6351	55	1.6351
Sun, Sep 28, 2014	142	71.3394	69	2.3394
Sun, Oct 05, 2014	143	58.3570	57	1.3570
Sun, Oct 12, 2014	144	59.3163	57	2.3163
Sun, Oct 19, 2014	145	37.9928	37	0.9928
Sun, Oct 26, 2014	146	58.4440	56	2.4440
Sun, Nov 02, 2014	147	68.0251	63	5.0251
Sun, Nov 09, 2014	148	75.0632	70	5.0632
Sun, Nov 16, 2014	149	59.8863	55	4.8863

Sun, Nov 23, 2014	150	68.4836	64	4.4836
Sun, Nov 30, 2014	151	67.8825	66	1.8825
Sun, Dec 07, 2014	152	51.0163	50	1.0163
Sun, Dec 14, 2014	153	40.2553	39	1.2553
Sun, Dec 21, 2014	154	63.1826	61	2.1826
Sun, Dec 28, 2014	155	45.1633	43	2.1633
Sun, Jan 04, 2015	156	59.3000	54	5.3000
Sun, Jan 11, 2015	157	57.5546	53	4.5546
Sun, Jan 18, 2015	158	65.7629	60	5.7629
Sun, Jan 25, 2015	159	62.1223	59	3.1223
Sun, Feb 01, 2015	160	50.2396	49	1.2396
Sun, Feb 08, 2015	161	54.5119	54	0.5119
Sun, Feb 15, 2015	162	43.7034	43	0.7034
Sun, Feb 22, 2015	163	58.8194	58	0.8194
Sun, Mar 01, 2015	164	48.6917	47	1.6917
Sun, Mar 08, 2015	165	61.2847	59	2.2847
Sun, Mar 15, 2015	166	60.6998	58	2.6998
Sun, Mar 22, 2015	167	53.5063	51	2.5063
Sun, Mar 29, 2015	168	72.8151	71	1.8151
Sun, Apr 05, 2015	169	53.8194	52	1.8194
Sun, Apr 12, 2015	170	75.0898	72	3.0898
Sun, Apr 19, 2015	171	52.8881	50	2.8881
Sun, Apr 26, 2015	172	42.5419	39	3.5419
Sun, May 03, 2015	173	43.5470	40	3.5470
Sun, May 10, 2015	174	46.0525	43	3.0525
Sun, May 17, 2015	175	54.8755	52	2.8755
Sun, May 24, 2015	176	52.5032	51	1.5032
Sun, May 31, 2015	177	68.9116	68	0.9116
Sun, Jun 07, 2015	178	55.9688	55	0.9688
Sun, Jun 14, 2015	179	57.1150	55	2.1150
Sun, Jun 21, 2015	180	67.5893	66	1.5893
Sun, Jun 28, 2015	181	58.0675	56	2.0675

Sun, Jul 05, 2015	182	56.5228	55	1.5228
Sun, Jul 12, 2015	183	65.8611	65	0.8611
Sun, Jul 19, 2015	184	61.1048	60	1.1048
Sun, Jul 26, 2015	185	42.7356	42	0.7356
Sun, Aug 02, 2015	186	68.3963	67	1.3963
Sun, Aug 09, 2015	187	64.0136	60	4.0136
Sun, Aug 16, 2015	188	45.2336	42	3.2336
Sun, Aug 23, 2015	189	59.8710	55	4.8710
Sun, Aug 30, 2015	190	64.6345	58	6.6345
Sun, Sep 06, 2015	191	52.2871	50	2.2871
Sun, Sep 13, 2015	192	49.6687	47	2.6687
Sun, Sep 20, 2015	193	54.7761	53	1.7761
Sun, Sep 27, 2015	194	47.4620	47	0.4620
Sun, Oct 04, 2015	195	58.8404	58	0.8404
Sun, Oct 11, 2015	196	57.7437	57	0.7437
Sun, Oct 18, 2015	197	58.0549	57	1.0549
Sun, Oct 25, 2015	198	59.6727	59	0.6727
Sun, Nov 01, 2015	199	52.7734	52	0.7734
Sun, Nov 08, 2015	200	59.1958	59	0.1958
Sun, Nov 15, 2015	201	49.3206	49	0.3206
Sun, Nov 22, 2015	202	65.6986	65	0.6986
Sun, Nov 29, 2015	203	61.5064	60	1.5064
Sun, Dec 06, 2015	204	76.3068	74	2.3068
Sun, Dec 13, 2015	205	63.8028	62	1.8028
Sun, Dec 20, 2015	206	69.8092	67	2.8092
Sun, Dec 27, 2015	207	58.0666	57	1.0666
Sun, Jan 03, 2016	208	69.6255	68	1.6255
Sun, Jan 10, 2016	209	73.6061	72	1.6061
Sun, Jan 17, 2016	210	58.8734	58	0.8734
Sun, Jan 24, 2016	211	82.5743	81	1.5743
Sun, Jan 31, 2016	212	68.3473	66	2.3473
Sun, Feb 07, 2016	213	62.4875	60	2.4875

Sun, Feb 14, 2016	214	61.5096	59	2.5096
Sun, Feb 21, 2016	215	60.6060	58	2.6060
Sun, Feb 28, 2016	216	54.9446	54	0.9446
Sun, Mar 06, 2016	217	49.2807	49	0.2807
Sun, Mar 13, 2016	218	33.1220	33	0.1220
Sun, Mar 20, 2016	219	58.2113	57	1.2113
Sun, Mar 27, 2016	220	51.6566	48	3.6566
Sun, Apr 03, 2016	221	69.5375	63	6.5375
Sun, Apr 10, 2016	222	65.3253	59	6.3253
Sun, Apr 17, 2016	223	59.4583	53	6.4583
Sun, Apr 24, 2016	224	56.6151	55	1.6151
Sun, May 01, 2016	225	56.7278	55	1.7278
Sun, May 08, 2016	226	64.4324	64	0.4324
Sun, May 15, 2016	227	63.5158	63	0.5158
Sun, May 22, 2016	228	64.4709	64	0.4709
Sun, May 29, 2016	229	62.2364	62	0.2364
Sun, Jun 05, 2016	230	49.3827	49	0.3827
Sun, Jun 12, 2016	231	54.3852	54	0.3852
Sun, Jun 19, 2016	232	74.1371	73	1.1371
Sun, Jun 26, 2016	233	68.3843	67	1.3843
Sun, Jul 03, 2016	234	61.5316	59	2.5316
Sun, Jul 10, 2016	235	72.4453	71	1.4453
Sun, Jul 17, 2016	236	61.2828	59	2.2828
Sun, Jul 24, 2016	237	76.4407	75	1.4407
Sun, Jul 31, 2016	238	51.3091	50	1.3091
Sun, Aug 07, 2016	239	44.0796	42	2.0796
Sun, Aug 14, 2016	240	57.5107	54	3.5107
Sun, Aug 21, 2016	241	57.0806	54	3.0806
Sun, Aug 28, 2016	242	68.7609	64	4.7609
Sun, Sep 04, 2016	243	49.2324	48	1.2324
Sun, Sep 11, 2016	244	69.6310	67	2.6310
Sun, Sep 18, 2016	245	49.9119	48	1.9119

Sun, Sep 25, 2016	246	91.3691	86	5.3691
Sun, Oct 02, 2016	247	65.4366	59	6.4366
Sun, Oct 09, 2016	248	75.0752	65	10.0752
Sun, Oct 16, 2016	249	56.1347	50	6.1347
Sun, Oct 23, 2016	250	54.8158	48	6.8158
Sun, Oct 30, 2016	251	51.4877	48	3.4877
Sun, Nov 06, 2016	252	60.1662	59	1.1662
Sun, Nov 13, 2016	253	62.8589	61	1.8589
Sun, Nov 20, 2016	254	53.7671	53	0.7671
Sun, Nov 27, 2016	255	63.6224	63	0.6224
Sun, Dec 04, 2016	256	67.5064	66	1.5064
Sun, Dec 11, 2016	257	86.0262	85	1.0262
Sun, Dec 18, 2016	258	57.0492	56	1.0492
Sun, Dec 25, 2016	259	63.8169	61	2.8169
Sun, Jan 01, 2017	260	58.0440	55	3.0440
		Average Error	Average Error	3.9043



APPENDIX E: Performance for Florida House Price Index

Model Performance for Florida House Price Index

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Feb 10, 2013	57	52	54.9720	2.9720
Sun, Feb 17, 2013	58	51	53.4899	2.4899
Sun, Feb 24, 2013	59	52	53.3708	1.3708
Sun, Mar 03, 2013	60	51	51.2809	0.2809
Sun, Mar 10, 2013	61	51	51.0190	0.0190
Sun, Mar 17, 2013	62	55	55.0115	0.0115
Sun, Mar 24, 2013	63	28	28.0699	0.0699
Sun, Mar 31, 2013	64	38	45.5072	7.5072
Sun, Apr 07, 2013	65	46	56.4651	10.4651
Sun, Apr 14, 2013	66	50	55.9634	5.9634
Sun, Apr 21, 2013	67	50	51.5680	1.5680
Sun, Apr 28, 2013	68	43	43.3481	0.3481
Sun, May 05, 2013	69	52	52.5587	0.5587
Sun, May 12, 2013	70	64	65.5865	1.5865
Sun, May 19, 2013	71	42	43.5342	1.5342
Sun, May 26, 2013	72	42	46.1513	4.1513
Sun, Jun 02, 2013	73	51	55.0229	4.0229
Sun, Jun 09, 2013	74	67	69.7883	2.7883
Sun, Jun 16, 2013	75	47	49.2255	2.2255
Sun, Jun 23, 2013	76	58	63.2058	5.2058
Sun, Jun 30, 2013	77	48	51.8944	3.8944
Sun, Jul 07, 2013	78	57	59.9359	2.9359
Sun, Jul 14, 2013	79	55	56.8524	1.8524
Sun, Jul 21, 2013	80	63	64.1208	1.1208
Sun, Jul 28, 2013	81	46	46.5825	0.5825
Sun, Aug 04, 2013	82	58	60.9060	2.9060
Sun, Aug 11, 2013	83	65	69.3019	4.3019
Sun, Aug 18, 2013	84	52	54.1722	2.1722

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Aug 25, 2013	85	64	66.1995	2.1995
Sun, Sep 01, 2013	86	60	62.4441	2.4441
Sun, Sep 08, 2013	87	44	45.1702	1.1702
Sun, Sep 15, 2013	88	44	46.1604	2.1604
Sun, Sep 22, 2013	89	66	68.6409	2.6409
Sun, Sep 29, 2013	90	63	68.3060	5.3060
Sun, Oct 06, 2013	91	59	63.0292	4.0292
Sun, Oct 13, 2013	92	53	54.3954	1.3954
Sun, Oct 20, 2013	93	54	54.3788	0.3788
Sun, Oct 27, 2013	94	45	45.2466	0.2466
Sun, Nov 03, 2013	95	51	51.8176	0.8176
Sun, Nov 10, 2013	96	61	62.2432	1.2432
Sun, Nov 17, 2013	97	47	48.1713	1.1713
Sun, Nov 24, 2013	98	48	50.1361	2.1361
Sun, Dec 01, 2013	99	56	57.8280	1.8280
Sun, Dec 08, 2013	100	55	56.1066	1.1066
Sun, Dec 15, 2013	101	56	56.5569	0.5569
Sun, Dec 22, 2013	102	55	55.2026	0.2026
Sun, Dec 29, 2013	103	63	63.0202	0.0202
Sun, Jan 05, 2014	104	58	58.4686	0.4686
Sun, Jan 12, 2014	105	50	50.5266	0.5266
Sun, Jan 19, 2014	106	64	64.9526	0.9526
Sun, Jan 26, 2014	107	62	64.2388	2.2388
Sun, Feb 02, 2014	108	46	47.3138	1.3138
Sun, Feb 09, 2014	109	52	54.4608	2.4608
Sun, Feb 16, 2014	110	69	71.9733	2.9733
Sun, Feb 23, 2014	111	64	67.4059	3.4059
Sun, Mar 02, 2014	112	57	59.1301	2.1301
Sun, Mar 09, 2014	113	49	49.9580	0.9580
Sun, Mar 16, 2014	114	61	61.9828	0.9828
Sun, Mar 23, 2014	115	58	59.8472	1.8472

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Mar 30, 2014	116	52	53.2497	1.2497
Sun, Apr 06, 2014	117	63	63.8215	0.8215
Sun, Apr 13, 2014	118	53	54.1144	1.1144
Sun, Apr 20, 2014	119	55	56.6276	1.6276
Sun, Apr 27, 2014	120	59	60.0687	1.0687
Sun, May 04, 2014	121	71	71.4945	0.4945
Sun, May 11, 2014	122	74	75.2506	1.2506
Sun, May 18, 2014	123	66	67.0220	1.0220
Sun, May 25, 2014	124	62	62.6962	0.6962
Sun, Jun 01, 2014	125	67	67.4882	0.4882
Sun, Jun 08, 2014	126	54	54.3271	0.3271
Sun, Jun 15, 2014	127	71	72.6299	1.6299
Sun, Jun 22, 2014	128	61	64.1727	3.1727
Sun, Jun 29, 2014	129	68	71.2123	3.2123
Sun, Jul 06, 2014	130	57	58.4394	1.4394
Sun, Jul 13, 2014	131	63	64.3536	1.3536
Sun, Jul 20, 2014	132	56	57.0496	1.0496
Sun, Jul 27, 2014	133	73	74.0597	1.0597
Sun, Aug 03, 2014	134	56	58.0847	2.0847
Sun, Aug 10, 2014	135	65	68.9578	3.9578
Sun, Aug 17, 2014	136	46	48.2263	2.2263
Sun, Aug 24, 2014	137	66	70.6460	4.6460
Sun, Aug 31, 2014	138	76	84.2074	8.2074
Sun, Sep 07, 2014	139	47	50.7169	3.7169
Sun, Sep 14, 2014	140	49	55.1640	6.1640
Sun, Sep 21, 2014	141	62	68.0908	6.0908
Sun, Sep 28, 2014	142	64	67.6853	3.6853
Sun, Oct 05, 2014	143	74	75.7307	1.7307
Sun, Oct 12, 2014	144	47	47.8173	0.8173
Sun, Oct 19, 2014	145	63	69.1131	6.1131
Sun, Oct 26, 2014	146	59	66.3282	7.3282

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Nov 02, 2014	147	55	58.6624	3.6624
Sun, Nov 09, 2014	148	66	67.0701	1.0701
Sun, Nov 16, 2014	149	64	65.0804	1.0804
Sun, Nov 23, 2014	150	70	71.0313	1.0313
Sun, Nov 30, 2014	151	61	61.5246	0.5246
Sun, Dec 07, 2014	152	57	57.6578	0.6578
Sun, Dec 14, 2014	153	83	83.9032	0.9032
Sun, Dec 21, 2014	154	44	46.8639	2.8639
Sun, Dec 28, 2014	155	52	64.0137	12.0137
Sun, Jan 04, 2015	156	71	85.0043	14.0043
Sun, Jan 11, 2015	157	51	56.6510	5.6510
Sun, Jan 18, 2015	158	56	61.0772	5.0772
Sun, Jan 25, 2015	159	76	80.7514	4.7514
Sun, Feb 01, 2015	160	57	60.3771	3.3771
Sun, Feb 08, 2015	161	37	39.7721	2.7721
Sun, Feb 15, 2015	162	60	67.6366	7.6366
Sun, Feb 22, 2015	163	67	79.6289	12.6289
Sun, Mar 01, 2015	164	62	69.9221	7.9221
Sun, Mar 08, 2015	165	74	77.0434	3.0434
Sun, Mar 15, 2015	166	49	49.8644	0.8644
Sun, Mar 22, 2015	167	57	61.9293	4.9293
Sun, Mar 29, 2015	168	89	96.4686	7.4686
Sun, Apr 05, 2015	169	75	83.9104	8.9104
Sun, Apr 12, 2015	170	66	72.4144	6.4144
Sun, Apr 19, 2015	171	54	56.5651	2.5651
Sun, Apr 26, 2015	172	93	95.6193	2.6193
Sun, May 03, 2015	173	82	93.9243	11.9243
Sun, May 10, 2015	174	74	83.8895	9.8895
Sun, May 17, 2015	175	53	55.8317	2.8317
Sun, May 24, 2015	176	74	78.0207	4.0207
Sun, May 31, 2015	177	64	70.0718	6.0718

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Jun 07, 2015	178	65	69.5930	4.5930
Sun, Jun 14, 2015	179	61	62.5091	1.5091
Sun, Jun 21, 2015	180	64	64.3111	0.3111
Sun, Jun 28, 2015	181	54	54.1445	0.1445
Sun, Jul 05, 2015	182	70	70.9721	0.9721
Sun, Jul 12, 2015	183	69	71.8292	2.8292
Sun, Jul 19, 2015	184	71	73.2595	2.2595
Sun, Jul 26, 2015	185	81	81.8184	0.8184
Sun, Aug 02, 2015	186	51	51.3982	0.3982
Sun, Aug 09, 2015	187	95	104.3952	9.3952
Sun, Aug 16, 2015	188	82	102.9845	20.9845
Sun, Aug 23, 2015	189	85	101.8751	16.8751
Sun, Aug 30, 2015	190	58	61.7692	3.7692
Sun, Sep 06, 2015	191	69	73.5706	4.5706
Sun, Sep 13, 2015	192	72	77.2528	5.2528
Sun, Sep 20, 2015	193	75	77.5576	2.5576
Sun, Sep 27, 2015	194	59	59.3421	0.3421
Sun, Oct 04, 2015	195	86	88.2021	2.2021
Sun, Oct 11, 2015	196	52	56.4014	4.4014
Sun, Oct 18, 2015	197	67	78.7147	11.7147
Sun, Oct 25, 2015	198	77	88.6732	11.6732
Sun, Nov 01, 2015	199	83	88.8889	5.8889
Sun, Nov 08, 2015	200	74	75.4492	1.4492
Sun, Nov 15, 2015	201	73	73.7835	0.7835
Sun, Nov 22, 2015	202	87	87.5469	0.5469
Sun, Nov 29, 2015	203	75	76.1364	1.1364
Sun, Dec 06, 2015	204	49	50.0816	1.0816
Sun, Dec 13, 2015	205	64	69.8272	5.8272
Sun, Dec 20, 2015	206	62	68.6928	6.6928
Sun, Dec 27, 2015	207	80	84.4530	4.4530
Sun, Jan 03, 2016	208	82	85.1565	3.1565

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Jan 10, 2016	209	57	58.5407	1.5407
Sun, Jan 17, 2016	210	59	62.9070	3.9070
Sun, Jan 24, 2016	211	73	76.9995	3.9995
Sun, Jan 31, 2016	212	77	79.9944	2.9944
Sun, Feb 07, 2016	213	61	62.2185	1.2185
Sun, Feb 14, 2016	214	67	69.0711	2.0711
Sun, Feb 21, 2016	215	68	69.7960	1.7960
Sun, Feb 28, 2016	216	79	79.9076	0.9076
Sun, Mar 06, 2016	217	92	93.0108	1.0108
Sun, Mar 13, 2016	218	57	58.0934	1.0934
Sun, Mar 20, 2016	219	64	71.0975	7.0975
Sun, Mar 27, 2016	220	63	69.4877	6.4877
Sun, Apr 03, 2016	221	76	78.9262	2.9262
Sun, Apr 10, 2016	222	63	64.0786	1.0786
Sun, Apr 17, 2016	223	100	102.9529	2.9529
Sun, Apr 24, 2016	224	79	87.7614	8.7614
Sun, May 01, 2016	225	90	100.4684	10.4684
Sun, May 08, 2016	226	66	70.0055	4.0055
Sun, May 15, 2016	227	84	88.7173	4.7173
Sun, May 22, 2016	228	71	75.7404	4.7404
Sun, May 29, 2016	229	86	90.2781	4.2781
Sun, Jun 05, 2016	230	69	71.4615	2.4615
Sun, Jun 12, 2016	231	84	87.3507	3.3507
Sun, Jun 19, 2016	232	63	65.6285	2.6285
Sun, Jun 26, 2016	233	81	85.7196	4.7196
Sun, Jul 03, 2016	234	73	77.8558	4.8558
Sun, Jul 10, 2016	235	83	86.5184	3.5184
Sun, Jul 17, 2016	236	83	84.7067	1.7067
Sun, Jul 24, 2016	237	71	71.5900	0.5900
Sun, Jul 31, 2016	238	82	83.0505	1.0505
Sun, Aug 07, 2016	239	61	62.1516	1.1516

Date	Week <i>i</i>	House Price	Forecast Value	 Error
Sun, Aug 14, 2016	240	85	89.2065	4.2065
Sun, Aug 21, 2016	241	69	74.9330	5.9330
Sun, Aug 28, 2016	242	65	69.9589	4.9589
Sun, Sep 04, 2016	243	86	89.0232	3.0232
Sun, Sep 11, 2016	244	66	68.7247	2.7247
Sun, Sep 18, 2016	245	95	100.9504	5.9504
Sun, Sep 25, 2016	246	59	64.7096	5.7096
Sun, Oct 02, 2016	247	66	76.6654	10.6654
Sun, Oct 09, 2016	248	62	69.2784	7.2784
Sun, Oct 16, 2016	249	63	65.4825	2.4825
Sun, Oct 23, 2016	250	63	63.2227	0.2227
Sun, Oct 30, 2016	251	64	64.0427	0.0427
Sun, Nov 06, 2016	252	60	60.0086	0.0086
Sun, Nov 13, 2016	253	59	59.1113	0.1113
Sun, Nov 20, 2016	254	62	62.1155	0.1155
Sun, Nov 27, 2016	255	42	42.0742	0.0742
Sun, Dec 04, 2016	256	62	66.0930	4.0930
Sun, Dec 11, 2016	257	59	66.5204	7.5204
Sun, Dec 18, 2016	258	69	74.8630	5.8630
Sun, Dec 25, 2016	259	61	63.0309	2.0309
Sun, Jan 01, 2017	260	78	79.3193	1.3193
Average Error				3.3444

APPENDIX F: Performance for Malaysia House Price Index

Model Performance for Malaysia House Price Index

Date	Quarter	House Price	Forecast Value	Error
2003 Q1	17	107.2	107.2276	0.0276
Q2	18	107.1	107.1207	0.0207
Q3	19	110.6	110.6120	0.0120
Q4	20	111.2	111.2201	0.0201
2004 Q1	21	112.8	112.8344	0.0344
Q2	22	113.1	113.1202	0.0202
Q3	23	113.4	113.4165	0.0165
Q4	24	114	114.0095	0.0095
2005 Q1	25	115	115.0063	0.0063
Q2	26	116.9	116.9054	0.0054
Q3	27	116.4	116.4083	0.0083
Q4	28	116.9	116.9108	0.0108
2006 Q1	29	117.7	117.7062	0.0062
Q2	30	118.5	118.5047	0.0047
Q3	31	118.8	118.8044	0.0044
Q4	32	122.4	122.4037	0.0037
2007 Q1	33	123.4	123.4144	0.0144
Q2	34	123.7	123.7302	0.0302
Q3	35	125.2	125.2165	0.0165
Q4	36	125.9	125.9119	0.0119
2008 Q1	37	128.7	128.7112	0.0112
Q2	38	128.9	128.9139	0.0139
Q3	39	131.4	131.4203	0.0203
Q4	40	129	129.0153	0.0153
2009 Q1	41	129.6	129.6231	0.0231
Q2	42	132.2	132.2213	0.0213
Q3	43	133.3	133.3179	0.0179
Q4	44	136.1	136.1220	0.0220

2010 Q1	45	136.9	136.9199	0.0199
Q2	46	140.3	140.3238	0.0238
Q3	47	143.7	143.7233	0.0233
Q4	48	147.2	147.2401	0.0401
2011 Q1	49	149.1	149.1471	0.0471
Q2	50	155.1	155.1463	0.0463
Q3	51	157.8	157.8576	0.0576
Q4	52	161.9	161.9871	0.0871
2012 Q1	53	167	167.0673	0.0673
Q2	54	172.4	172.4798	0.0798
Q3	55	176.5	176.5971	0.0971
Q4	56	181.7	181.8001	0.1001
2013 Q1	57	184.9	184.9918	0.0918
Q2	58	191.8	191.8907	0.0907
Q3	59	198	198.0919	0.0919
Q4	60	199.1	199.2260	0.1260
2014 Q1	61	202.7	202.8076	0.1076
Q2	62	208	208.0684	0.0684
Q3	63	213.6	213.6708	0.0708
Q4	64	215	215.0843	0.0843
2015 Q1	65	218.5	218.5768	0.0768
			Average Error	0.0393

APPENDIX G: Performance for NASDAQ Index

Model Performance for NASDAQ Index

Date	Day i	Close Price	Forecast Value	 Error
Mon, Mar 23, 2015	55	5,010.9702	5,011.1111	0.1409
Tue, Mar 24, 2015	56	4,994.7300	4,994.8429	0.1130
Wed, Mar 25, 2015	57	4,876.5200	4,876.5756	0.0556
Thu, Mar 26, 2015	58	4,863.3599	4,864.9887	1.6288
Fri, Mar 27, 2015	59	4,891.2202	4,892.2749	1.0547
Mon, Mar 30, 2015	60	4,947.4399	4,947.6583	0.2183
Tue, Mar 31, 2015	61	4,900.8799	4,901.3358	0.4559
Wed, Apr 01, 2015	62	4,880.2300	4,880.7286	0.4987
Thu, Apr 02, 2015	63	4,886.9399	4,887.1790	0.2390
Mon, Apr 06, 2015	64	4,917.3198	4,917.3816	0.0618
Tue, Apr 07, 2015	65	4,910.2300	4,910.3513	0.1213
Wed, Apr 08, 2015	66	4,950.8198	4,950.8983	0.0785
Thu, Apr 09, 2015	67	4,974.5601	4,974.7661	0.2060
Fri, Apr 10, 2015	68	4,995.9800	4,996.1726	0.1927
Mon, Apr 13, 2015	69	4,988.2500	4,988.3588	0.1088
Tue, Apr 14, 2015	70	4,977.2900	4,977.3385	0.0485
Wed, Apr 15, 2015	71	5,011.0200	5,011.0440	0.0239
Thu, Apr 16, 2015	72	5,007.7900	5,007.9323	0.1422
Fri, Apr 17, 2015	73	4,931.8101	4,931.8953	0.0852
Mon, Apr 20, 2015	74	4,994.6001	4,995.2821	0.6820
Tue, Apr 21, 2015	75	5,014.1001	5,014.9951	0.8950
Wed, Apr 22, 2015	76	5,035.1699	5,035.5569	0.3869
Thu, Apr 23, 2015	77	5,056.0601	5,056.1827	0.1227
Fri, Apr 24, 2015	78	5,092.0801	5,092.1770	0.0969
Mon, Apr 27, 2015	79	5,060.2500	5,060.4355	0.1855
Tue, Apr 28, 2015	80	5,055.4199	5,055.6330	0.2131
Wed, Apr 29, 2015	81	5,023.6401	5,023.7265	0.0864
Thu, Apr 30, 2015	82	4,941.4199	4,941.5450	0.1251

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Fri, May 01, 2015	83	5,005.3901	5,006.2506	0.8605
Mon, May 04, 2015	84	5,016.9302	5,017.9185	0.9883
Tue, May 05, 2015	85	4,939.3301	4,939.7003	0.3702
Wed, May 06, 2015	86	4,919.6401	4,920.3832	0.7431
Thu, May 07, 2015	87	4,945.5400	4,946.0393	0.4993
Fri, May 08, 2015	88	5,003.5498	5,003.7093	0.1595
Mon, May 11, 2015	89	4,993.5698	4,994.0269	0.4570
Tue, May 12, 2015	90	4,976.1899	4,976.4592	0.2693
Wed, May 13, 2015	91	4,981.6899	4,981.7609	0.0710
Thu, May 14, 2015	92	5,050.7998	5,050.8339	0.0341
Fri, May 15, 2015	93	5,048.2900	5,048.8482	0.5582
Mon, May 18, 2015	94	5,078.4399	5,078.7962	0.3563
Tue, May 19, 2015	95	5,070.0298	5,070.1718	0.1420
Wed, May 20, 2015	96	5,071.7402	5,071.8237	0.0835
Thu, May 21, 2015	97	5,090.7900	5,090.8049	0.0149
Fri, May 22, 2015	98	5,089.3599	5,089.4041	0.0442
Tue, May 26, 2015	99	5,032.7500	5,032.7769	0.0269
Wed, May 27, 2015	100	5,106.5898	5,106.9608	0.3709
Thu, May 28, 2015	101	5,097.9800	5,098.8377	0.8577
Fri, May 29, 2015	102	5,070.0298	5,070.4584	0.4286
Mon, Jun 01, 2015	103	5,082.9302	5,083.0724	0.1422
Tue, Jun 02, 2015	104	5,076.5200	5,076.6077	0.0877
Wed, Jun 03, 2015	105	5,099.2300	5,099.2559	0.0259
Thu, Jun 04, 2015	106	5,059.1201	5,059.1846	0.0645
Fri, Jun 05, 2015	107	5,068.4600	5,068.6802	0.2202
Mon, Jun 08, 2015	108	5,021.6299	5,021.7590	0.1291
Tue, Jun 09, 2015	109	5,013.8701	5,014.1384	0.2682
Wed, Jun 10, 2015	110	5,076.6899	5,076.8617	0.1717
Thu, Jun 11, 2015	111	5,082.5098	5,082.9860	0.4762
Fri, Jun 12, 2015	112	5,051.1001	5,051.3966	0.2965
Mon, Jun 15, 2015	113	5,029.9702	5,030.1157	0.1455

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Tue, Jun 16, 2015	114	5,055.5498	5,055.6805	0.1306
Wed, Jun 17, 2015	115	5,064.8799	5,064.9972	0.1174
Thu, Jun 18, 2015	116	5,132.9502	5,133.0147	0.0645
Fri, Jun 19, 2015	117	5,117.0000	5,117.5380	0.5380
Mon, Jun 22, 2015	118	5,153.9702	5,154.3388	0.3686
Tue, Jun 23, 2015	119	5,160.0898	5,160.2988	0.2090
Wed, Jun 24, 2015	120	5,122.4102	5,122.5228	0.1126
Thu, Jun 25, 2015	121	5,112.1899	5,112.3637	0.1738
Fri, Jun 26, 2015	122	5,080.5098	5,080.6252	0.1154
Mon, Jun 29, 2015	123	4,958.4702	4,958.5991	0.1288
Tue, Jun 30, 2015	124	4,986.8701	4,988.6415	1.7714
Wed, Jul 01, 2015	125	5,013.1201	5,014.3118	1.1917
Thu, Jul 02, 2015	126	5,009.2100	5,009.4678	0.2578
Mon, Jul 06, 2015	127	4,991.9399	4,992.0276	0.0877
Tue, Jul 07, 2015	128	4,997.4600	4,997.5095	0.0495
Wed, Jul 08, 2015	129	4,909.7598	4,909.7883	0.0285
Thu, Jul 09, 2015	130	4,922.3999	4,923.2934	0.8935
Fri, Jul 10, 2015	131	4,997.7002	4,998.2959	0.5957
Mon, Jul 13, 2015	132	5,071.5098	5,072.2576	0.7478
Tue, Jul 14, 2015	133	5,104.8901	5,105.9709	1.0808
Wed, Jul 15, 2015	134	5,098.9399	5,099.5192	0.5793
Thu, Jul 16, 2015	135	5,163.1802	5,163.3219	0.1418
Fri, Jul 17, 2015	136	5,210.1401	5,210.6355	0.4954
Mon, Jul 20, 2015	137	5,218.8599	5,219.4126	0.5527
Tue, Jul 21, 2015	138	5,208.1201	5,208.3189	0.1987
Wed, Jul 22, 2015	139	5,171.7700	5,171.8128	0.0428
Thu, Jul 23, 2015	140	5,146.4102	5,146.5701	0.1600
Fri, Jul 24, 2015	141	5,088.6299	5,088.7948	0.1650
Mon, Jul 27, 2015	142	5,039.7798	5,040.2047	0.4249
Tue, Jul 28, 2015	143	5,089.2100	5,089.7283	0.5184
Wed, Jul 29, 2015	144	5,111.7300	5,112.2125	0.4825

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Thu, Jul 30, 2015	145	5,128.7798	5,129.0424	0.2626
Fri, Jul 31, 2015	146	5,128.2798	5,128.3747	0.0949
Mon, Aug 03, 2015	147	5,115.3799	5,115.4109	0.0310
Tue, Aug 04, 2015	148	5,105.5498	5,105.5732	0.0234
Wed, Aug 05, 2015	149	5,139.9399	5,139.9640	0.0241
Thu, Aug 06, 2015	150	5,056.4399	5,056.5795	0.1396
Fri, Aug 07, 2015	151	5,043.5400	5,044.4035	0.8634
Mon, Aug 10, 2015	152	5,101.7998	5,102.3312	0.5314
Tue, Aug 11, 2015	153	5,036.7900	5,037.2398	0.4498
Wed, Aug 12, 2015	154	5,044.3901	5,045.1271	0.7370
Thu, Aug 13, 2015	155	5,033.5601	5,033.9006	0.3405
Fri, Aug 14, 2015	156	5,048.2402	5,048.2978	0.0575
Mon, Aug 17, 2015	157	5,091.7002	5,091.7440	0.0438
Tue, Aug 18, 2015	158	5,059.3501	5,059.5833	0.2332
Wed, Aug 19, 2015	159	5,019.0498	5,019.3052	0.2554
Thu, Aug 20, 2015	160	4,877.4902	4,877.7573	0.2670
Fri, Aug 21, 2015	161	4,706.0400	4,708.3789	2.3388
Mon, Aug 24, 2015	162	4,526.2500	4,530.9615	4.7115
Tue, Aug 25, 2015	163	4,506.4902	4,512.6949	6.2047
Wed, Aug 26, 2015	164	4,697.5400	4,700.4851	2.9451
Thu, Aug 27, 2015	165	4,812.7100	4,817.8751	5.1651
Fri, Aug 28, 2015	166	4,828.3198	4,833.1004	4.7806
Mon, Aug 31, 2015	167	4,776.5098	4,777.9137	1.4039
Tue, Sep 01, 2015	168	4,636.1001	4,636.6176	0.5175
Wed, Sep 02, 2015	169	4,749.9800	4,752.6667	2.6867
Thu, Sep 03, 2015	170	4,733.5000	4,736.6868	3.1868
Fri, Sep 04, 2015	171	4,683.9199	4,685.1379	1.2180
Tue, Sep 08, 2015	172	4,811.9302	4,812.4132	0.4830
Wed, Sep 09, 2015	173	4,756.5298	4,758.7538	2.2240
Thu, Sep 10, 2015	174	4,796.2500	4,797.9323	1.6823
Fri, Sep 11, 2015	175	4,822.3398	4,822.9146	0.5748

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Mon, Sep 14, 2015	176	4,805.7598	4,806.0241	0.2644
Tue, Sep 15, 2015	177	4,860.5200	4,860.6341	0.1141
Wed, Sep 16, 2015	178	4,889.2402	4,889.6355	0.3952
Thu, Sep 17, 2015	179	4,893.9502	4,894.2842	0.3340
Fri, Sep 18, 2015	180	4,827.2300	4,827.3198	0.0898
Mon, Sep 21, 2015	181	4,828.9502	4,829.4885	0.5383
Tue, Sep 22, 2015	182	4,756.7202	4,757.0532	0.3330
Wed, Sep 23, 2015	183	4,752.7402	4,753.3978	0.6575
Thu, Sep 24, 2015	184	4,734.4800	4,734.8859	0.4059
Fri, Sep 25, 2015	185	4,686.5000	4,686.5851	0.0851
Mon, Sep 28, 2015	186	4,543.9702	4,544.2769	0.3067
Tue, Sep 29, 2015	187	4,517.3198	4,519.9775	2.6577
Wed, Sep 30, 2015	188	4,620.1602	4,621.8918	1.7316
Thu, Oct 01, 2015	189	4,627.0801	4,628.6667	1.5866
Fri, Oct 02, 2015	190	4,707.7798	4,708.7134	0.9336
Mon, Oct 05, 2015	191	4,781.2598	4,782.1943	0.9345
Tue, Oct 06, 2015	192	4,748.3599	4,749.5638	1.2040
Wed, Oct 07, 2015	193	4,791.1499	4,791.7665	0.6166
Thu, Oct 08, 2015	194	4,810.7900	4,811.1580	0.3679
Fri, Oct 09, 2015	195	4,830.4702	4,830.6836	0.2134
Mon, Oct 12, 2015	196	4,838.6401	4,838.7375	0.0974
Tue, Oct 13, 2015	197	4,796.6099	4,796.6554	0.0456
Wed, Oct 14, 2015	198	4,782.8501	4,783.0698	0.2197
Thu, Oct 15, 2015	199	4,870.1001	4,870.2613	0.1612
Fri, Oct 16, 2015	200	4,886.6899	4,887.6391	0.9491
Mon, Oct 19, 2015	201	4,905.4702	4,906.0973	0.6271
Tue, Oct 20, 2015	202	4,880.9702	4,881.0962	0.1260
Wed, Oct 21, 2015	203	4,840.1201	4,840.2339	0.1138
Thu, Oct 22, 2015	204	4,920.0498	4,920.3024	0.2526
Fri, Oct 23, 2015	205	5,031.8599	5,032.7743	0.9144
Mon, Oct 26, 2015	206	5,034.7002	5,036.6755	1.9753

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Tue, Oct 27, 2015	207	5,030.1499	5,031.1410	0.9911
Wed, Oct 28, 2015	208	5,095.6899	5,095.8080	0.1181
Thu, Oct 29, 2015	209	5,074.2700	5,074.7892	0.5192
Fri, Oct 30, 2015	210	5,053.7500	5,054.1199	0.3699
Mon, Nov 02, 2015	211	5,127.1499	5,127.2673	0.1174
Tue, Nov 03, 2015	212	5,145.1299	5,145.7890	0.6591
Wed, Nov 04, 2015	213	5,142.4800	5,142.9155	0.4355
Thu, Nov 05, 2015	214	5,127.7402	5,127.8075	0.0673
Fri, Nov 06, 2015	215	5,147.1201	5,147.1582	0.0381
Mon, Nov 09, 2015	216	5,095.2998	5,095.3602	0.0604
Tue, Nov 10, 2015	217	5,083.2402	5,083.5688	0.3286
Wed, Nov 11, 2015	218	5,067.0200	5,067.2305	0.2105
Thu, Nov 12, 2015	219	5,005.0801	5,005.1408	0.0607
Fri, Nov 13, 2015	220	4,927.8799	4,928.3336	0.4538
Mon, Nov 16, 2015	221	4,984.6201	4,985.5940	0.9739
Tue, Nov 17, 2015	222	4,986.0200	4,986.8694	0.8494
Wed, Nov 18, 2015	223	5,075.2002	5,075.5006	0.3004
Thu, Nov 19, 2015	224	5,073.6401	5,074.5979	0.9578
Fri, Nov 20, 2015	225	5,104.9199	5,105.5196	0.5997
Mon, Nov 23, 2015	226	5,102.4800	5,102.6565	0.1765
Tue, Nov 24, 2015	227	5,102.8101	5,102.8976	0.0876
Wed, Nov 25, 2015	228	5,116.1401	5,116.1521	0.0120
Fri, Nov 27, 2015	229	5,127.5200	5,127.5430	0.0230
Mon, Nov 30, 2015	230	5,108.6699	5,108.6979	0.0280
Tue, Dec 01, 2015	231	5,156.3101	5,156.3612	0.0512
Wed, Dec 02, 2015	232	5,123.2202	5,123.5012	0.2810
Thu, Dec 03, 2015	233	5,037.5298	5,037.8125	0.2827
Fri, Dec 04, 2015	234	5,142.2700	5,143.2086	0.9386
Mon, Dec 07, 2015	235	5,101.8101	5,103.5998	1.7897
Tue, Dec 08, 2015	236	5,098.2402	5,099.2768	1.0366
Wed, Dec 09, 2015	237	5,022.8701	5,023.0847	0.2146

Date	Day <i>i</i>	Close Price	Forecast Value	 Error
Thu, Dec 10, 2015	238	5,045.1699	5,045.8516	0.6816
Fri, Dec 11, 2015	239	4,933.4702	4,933.9370	0.4668
Mon, Dec 14, 2015	240	4,952.2300	4,953.7398	1.5099
Tue, Dec 15, 2015	241	4,995.3599	4,996.3365	0.9766
Wed, Dec 16, 2015	242	5,071.1299	5,071.4797	0.3498
Thu, Dec 17, 2015	243	5,002.5498	5,003.3685	0.8187
Fri, Dec 18, 2015	244	4,923.0801	4,924.0367	0.9566
Mon, Dec 21, 2015	245	4,968.9199	4,970.0413	1.1214
Tue, Dec 22, 2015	246	5,001.1099	5,001.8770	0.7672
Wed, Dec 23, 2015	247	5,045.9302	5,046.2734	0.3432
Thu, Dec 24, 2015	248	5,048.4902	5,048.8314	0.3411
Mon, Dec 28, 2015	249	5,040.9902	5,041.1547	0.1644
Tue, Dec 29, 2015	250	5,107.9399	5,107.9669	0.0270
Wed, Dec 30, 2015	251	5,065.8501	5,066.3667	0.5166
Thu, Dec 31, 2015	252	5,007.4102	5,007.9294	0.5193
			Average Error	0.5878

APPENDIX H: Performance for Dow Jones Index

Model Performance for Dow Jones Index

Day	Adj Close	Forecast Value	Error
1	46.15	46.1885	0.0385
2	45.98	45.9899	0.0099
3	47	47.0105	0.0105
4	47.28	47.2900	0.0100
5	47.4	47.4085	0.0085
6	47.25	47.2719	0.0219
7	47.51	47.5129	0.0029
8	47.36	47.3611	0.0011
9	47.33	47.3309	0.0009
10	47.63	47.6322	0.0022
11	47.67	47.6711	0.0011
12	47.1	47.1029	0.0029
13	47.09	47.0940	0.0040
14	47.19	47.1915	0.0015
15	47.1	47.1065	0.0065
16	47.4	47.4010	0.0010
17	46.75	46.7542	0.0042
18	45.84	45.8500	0.0100
19	45.83	45.8393	0.0093
20	45.05	45.0664	0.0164
21	44.73	44.7515	0.0215
22	45.38	45.3874	0.0074
23	44.99	45.0072	0.0172
24	44.97	44.9754	0.0054
25	44.59	44.6006	0.0106
26	45.46	45.4708	0.0108
27	44.69	44.7011	0.0111
28	45.22	45.2331	0.0131

Day	Adj Close	Forecast Value	Error
29	45.16	45.1805	0.0205
30	45.15	45.1640	0.0140
31	44.78	44.7873	0.0073
32	44.81	44.8113	0.0013
33	46.08	46.0940	0.0140
34	46.97	46.9914	0.0214
35	46.3	46.3164	0.0164
36	46.22	46.2602	0.0402
37	46.55	46.5696	0.0196
38	46.97	46.9818	0.0118
39	46.82	46.8223	0.0023
40	46.67	46.6733	0.0033
41	47.03	47.0349	0.0049
42	46.69	46.6925	0.0025
43	46.58	46.5819	0.0019
44	47.12	47.1255	0.0055
45	48.35	48.3665	0.0165
46	48.01	48.0230	0.0130
47	47.92	47.9331	0.0131
48	48.33	48.3619	0.0319
49	47.91	47.9156	0.0056
50	48.27	48.2732	0.0032
51	49.21	49.2218	0.0118
52	49.33	49.3403	0.0103
53	49.66	49.6673	0.0073
54	50	50.0190	0.0190
55	49.8	49.8022	0.0022
56	49.21	49.2154	0.0054
57	49.88	49.8881	0.0081
58	49.84	49.8452	0.0052
59	49.55	49.5590	0.0090

Day	Adj Close	Forecast Value	Error
60	49.1	49.1106	0.0106
61	48.86	48.8624	0.0024
62	50.03	50.0432	0.0132
63	50.08	50.0934	0.0134
64	49.16	49.1729	0.0129
65	48.95	48.9814	0.0314
66	49.44	49.4462	0.0062
67	49.7	49.7183	0.0183
68	49.21	49.2145	0.0045
69	48.95	48.9570	0.0070
70	49.25	49.2535	0.0035
71	49.58	49.5863	0.0063
72	49.49	49.4926	0.0026
73	48.84	48.8454	0.0054
74	49.4	49.4074	0.0074
75	49.76	49.7650	0.0050
76	50.24	50.2521	0.0121
77	50.43	50.4386	0.0086
78	50.8	50.8049	0.0049
79	51.15	51.1564	0.0064
80	51.19	51.1922	0.0022
81	50.24	50.2495	0.0095
82	49.6	49.6110	0.0110
83	49.71	49.7163	0.0063
84	50.17	50.1897	0.0197
85	50.33	50.3398	0.0098
86	50.02	50.0222	0.0022
87	50.04	50.0447	0.0047
88	50.75	50.7547	0.0047
89	51.48	51.4891	0.0091
90	51.71	51.7159	0.0059

Day	Adj Close	Forecast Value	Error
91	51.41	51.4226	0.0126
92	51.57	51.5810	0.0110
93	51.69	51.6919	0.0019
94	51.24	51.2433	0.0033
95	51.35	51.3519	0.0019
96	51.23	51.2312	0.0012
97	49.4	49.4278	0.0278
98	49.77	49.7931	0.0231
99	49.98	49.9946	0.0146
100	49.97	50.0324	0.0624
101	49.18	49.1890	0.0090
102	49.45	49.4558	0.0058
103	48.16	48.1754	0.0154
104	48.88	48.9071	0.0271
105	50	50.0218	0.0218
106	50.52	50.5657	0.0457
107	51.59	51.6169	0.0269
108	50.67	50.7091	0.0391
109	50.8	50.8157	0.0157
110	49.77	49.8016	0.0316
111	49.14	49.1652	0.0252
112	48.73	48.7387	0.0087
113	48.63	48.6518	0.0218
114	46.45	46.4943	0.0443
115	44.71	44.7683	0.0583
116	44.38	44.4210	0.0410
117	45.37	45.4810	0.1110
118	46.13	46.2076	0.0776
119	46.12	46.1330	0.0130
120	45.77	45.7945	0.0245
121	45.19	45.2058	0.0158

Day	Adj Close	Forecast Value	Error
122	45.41	45.4137	0.0037
123	45.84	45.8459	0.0059
124	45.32	45.3307	0.0107
125	44.25	44.2632	0.0132
126	45.36	45.3838	0.0238
127	44.05	44.0833	0.0333
128	44.45	44.4931	0.0431
129	43.74	43.7785	0.0385
130	43.67	43.7101	0.0401
131	44.22	44.2293	0.0093
132	43.52	43.5371	0.0171
133	42.92	42.9284	0.0084
134	42.47	42.4828	0.0128
135	41.45	41.4721	0.0221
136	39.24	39.2994	0.0594
137	38.31	38.3647	0.0547
138	39.93	40.0088	0.0788
139	42.41	42.6149	0.2049
140	42.79	42.8832	0.0932
141	42.56	42.6612	0.1012
142	40.52	40.6960	0.1760
143	41.23	41.2746	0.0446
144	41.66	41.6874	0.0274
145	40.93	41.0307	0.1007
146	42.88	42.9343	0.0543
147	42.59	42.6286	0.0386
148	42.56	42.5915	0.0315
149	42.58	42.6666	0.0866
150	41.9	41.9081	0.0081
151	42.42	42.4264	0.0064
152	43.75	43.7699	0.0199

Day	Adj Close	Forecast Value	Error
153	43.01	43.0398	0.0298
154	42.12	42.1450	0.0250
155	42.81	42.8610	0.0510
156	42.41	42.4313	0.0213
157	41.41	41.4394	0.0294
158	41.33	41.3492	0.0192
159	41.16	41.1687	0.0087
160	39.31	39.3619	0.0519
161	39.84	39.8712	0.0312
162	41.65	41.7011	0.0511
163	42.22	42.3350	0.1150
164	43.67	43.7178	0.0478
165	45.49	45.6209	0.1309
166	46.25	46.3008	0.0508
167	46.65	46.7209	0.0709
168	46.95	47.0287	0.0787
169	46.25	46.2691	0.0191
170	45.78	45.7893	0.0093
171	45.69	45.6956	0.0056
172	46.28	46.2936	0.0136
173	46.74	46.7491	0.0091
174	46.78	46.7834	0.0034
175	46.55	46.5585	0.0085
176	46.85	46.8556	0.0056
177	46.64	46.6414	0.0014
178	49.04	49.0875	0.0475
179	49.43	49.4743	0.0443
180	49.56	49.5869	0.0269
181	49.8	49.9179	0.1179
182	50.46	50.4698	0.0098
183	50	50.0054	0.0054

Day	Adj Close	Forecast Value	Error
184	50.76	50.7686	0.0086
185	50.68	50.6929	0.0129
186	51.06	51.0676	0.0076
187	50.47	50.4843	0.0143
188	50.7	50.7036	0.0036
189	50.93	50.9348	0.0048
190	50.79	50.7972	0.0072
191	50.8	50.8015	0.0015
192	50.79	50.7911	0.0011
193	49.54	49.5518	0.0118
194	50.24	50.2539	0.0139
195	50.74	50.7514	0.0114
196	50.74	50.7730	0.0330
197	52.22	52.2474	0.0274
198	52.38	52.3996	0.0196
199	52.38	52.3889	0.0089
200	52.06	52.1009	0.0409
201	52.44	52.4432	0.0032
202	51	51.0160	0.0160
203	51.09	51.1054	0.0154
204	51.21	51.2206	0.0106
205	52.48	52.5297	0.0497
206	51.37	51.3900	0.0200
207	50.94	50.9554	0.0154
208	52.37	52.4201	0.0501
209	51.11	51.1573	0.0473
210	50	50.0302	0.0302
211	55.96	56.2780	0.3180
212	53.94	54.2282	0.2882
213	52.43	52.6253	0.1953
214	50.38	51.0320	0.6520

Day	Adj Close	Forecast Value	Error
215	49.68	49.7958	0.1158
216	49.82	49.8800	0.0600
217	49.36	49.4381	0.0781
218	48.75	48.7652	0.0152
219	50.07	50.0875	0.0175
220	50.59	50.6096	0.0196
221	51.6	51.6241	0.0241
222	51.39	51.4324	0.0424
223	51.31	51.3203	0.0103
224	52.32	52.3469	0.0269
225	51.2	51.2166	0.0166
226	51.02	51.0321	0.0121



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